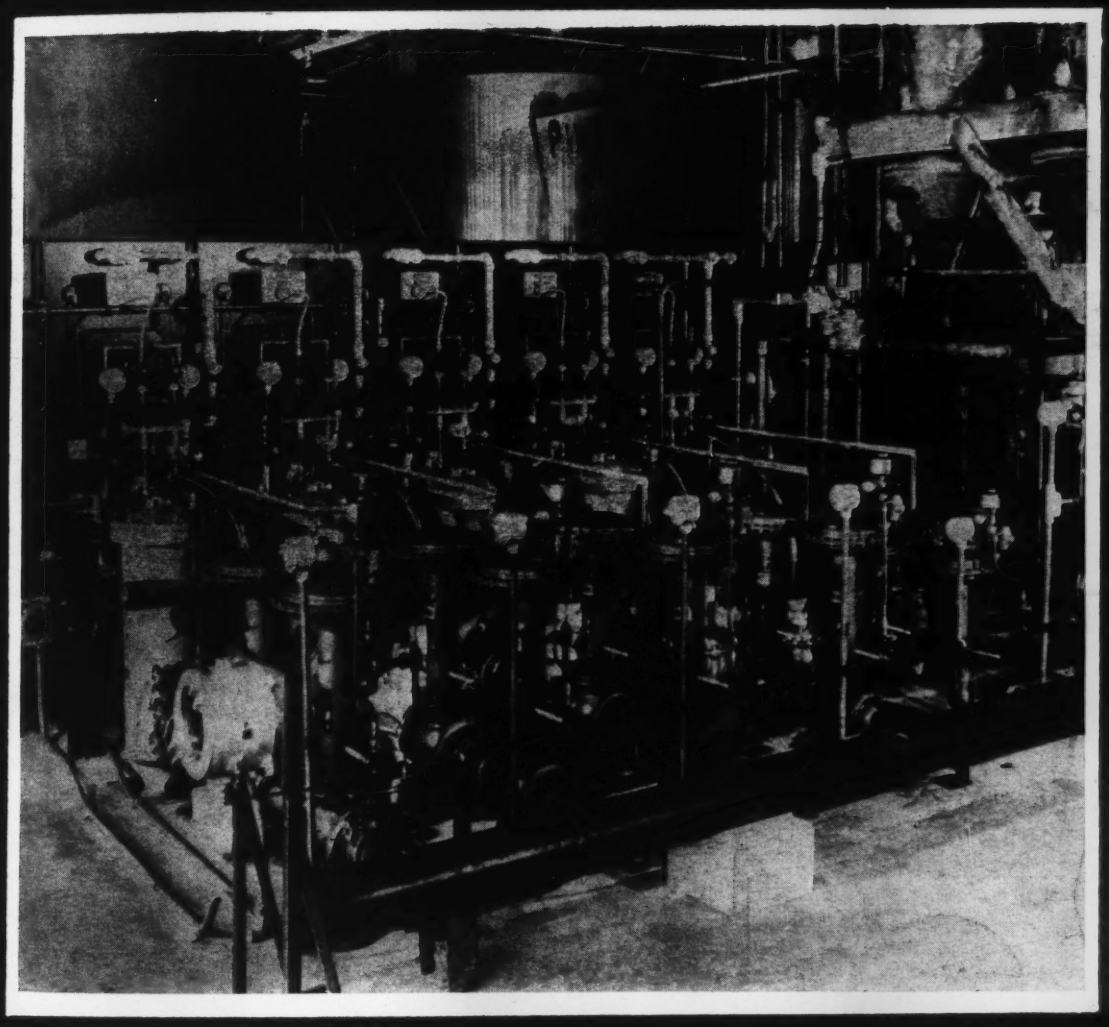
Instruments

THE MAGAZINE of MEASUREMENT and CONTROL

Vol. 24 | OCTOBER 1951 | No. 10

INCLUDING THE *Journal of the Instrument Society of America*

AND THE *Journal of the Southern California Meter Association*



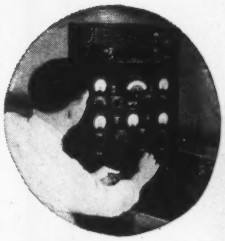
Continuous Automatic Lube Oil Blender

Photo courtesy Hammel-Dahl Company

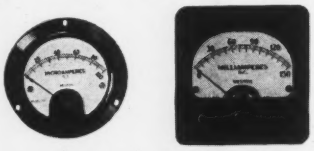
See story on Page 1132

To do important measurement jobs *Better... Quicker!*

Model 697 **VOLT-OHM-MILLIAMMETER** One of a line of pocket-size meters, Model 697 combines a selection of a-c and d-c voltage, d-c current, and resistance ranges. Ideal for maintenance testing and many inspection requirements.



Model 686 **ELECTRONIC TUBE ANALYZER** tests tubes under exact operating potentials. Accurately determines true mutual conductance of all tubes, in accordance with manufacturers' rated operating conditions, or under desired operating conditions.



PANEL and SWITCHBOARD INSTRUMENTS—a complete line of instruments in all types, sizes and ranges required for switchboard and panel needs . . . including d-c, a-c power frequencies and radio frequency, rectifier types and D.B. meters.

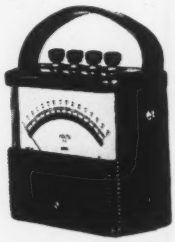
Model 622 **ULTRA-SENSITIVE INSTRUMENTS**—portable d-c and a-c thermo instruments for precision measurement of potentials and minute currents in electronics or laboratory research.

The same *dependability* evident in all **WESTON** standard instruments also is available in a broad line of *specialized* and *multi-purpose* instruments...all designed to do special and complex measurement jobs better, quicker, more economically. Whether for laboratory, shop or field requirements, first check instrument needs with **WESTON**. Consult the nearest representative, or write direct.

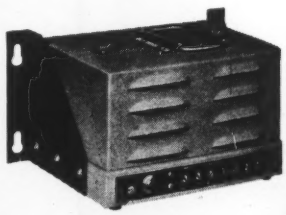
WESTON *Instruments*

WESTON Electrical Instrument Corporation
606 Frelinghuysen Avenue, Newark 5, New Jersey
Manufacturers of Weston and TAGliabue Instruments

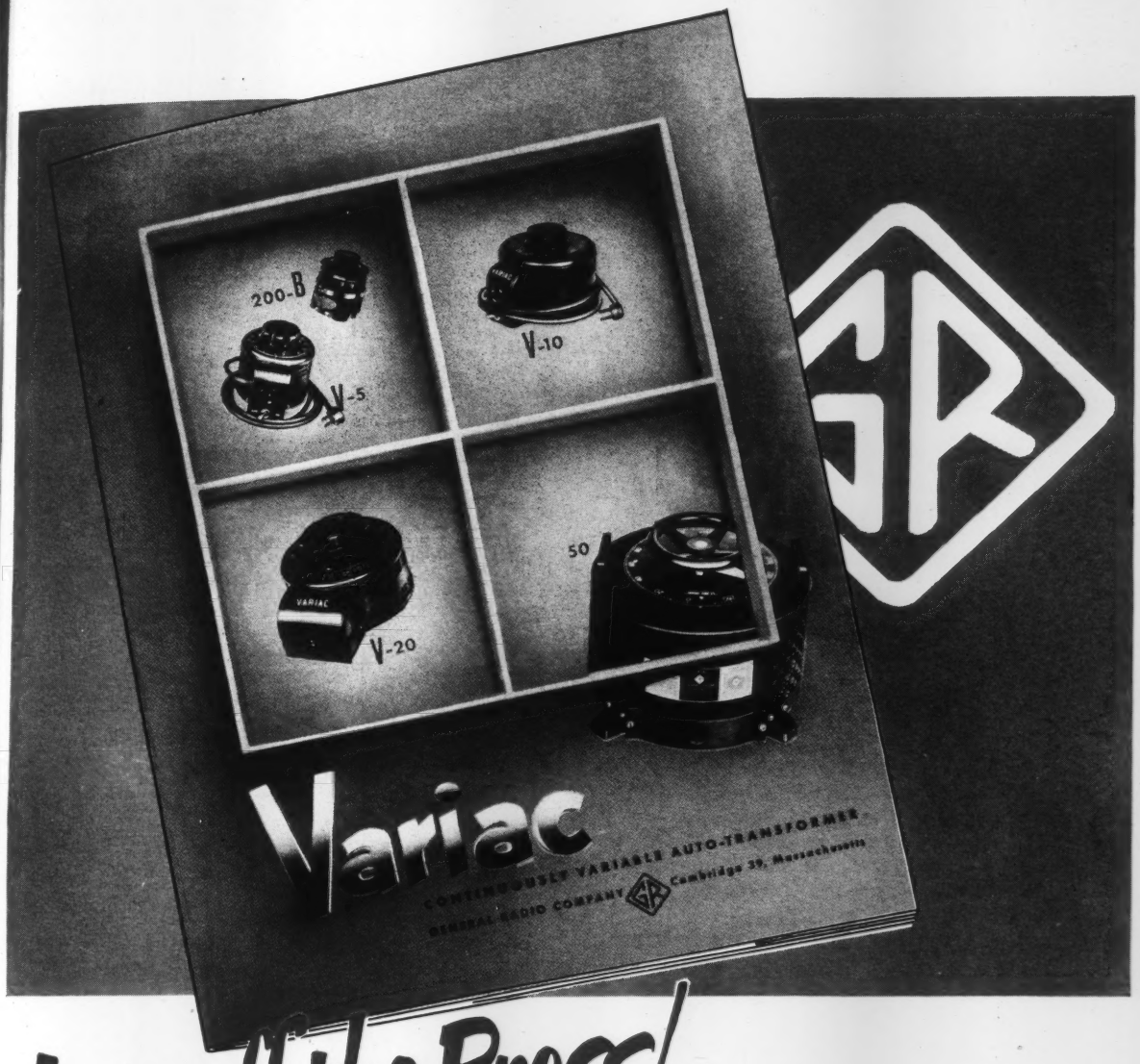
SENSITIVE RELAYS—a line of sensitive relays including the Model 705 which provides positive control at levels as low as ½ microampere. Non-chattering magnetic contacts handle up to 10 watts at 120 volts.



Model 901 **PORTABLE TEST INSTRUMENTS** available in d-c, Model 901 —and a-c, Model 904, single and multiple ranges of wide coverage. Excellent scale readability and shielding. Accuracy within ½ of 1%.



Model 1411 **INDUCTRONIC D-C AMPLIFIER**—stable amplifier provides high degree of resolution even at fractional loads. Reaches steady full scale deflection in fraction of a second. Interchangeable plug-in range standards for either microamperes or millivolts.



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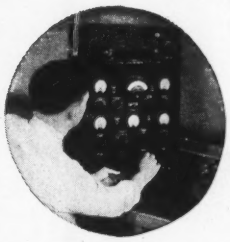

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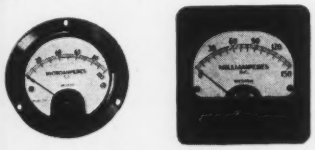

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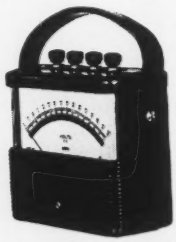

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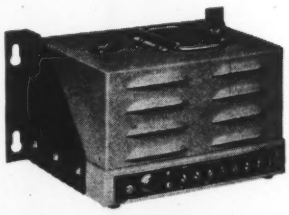

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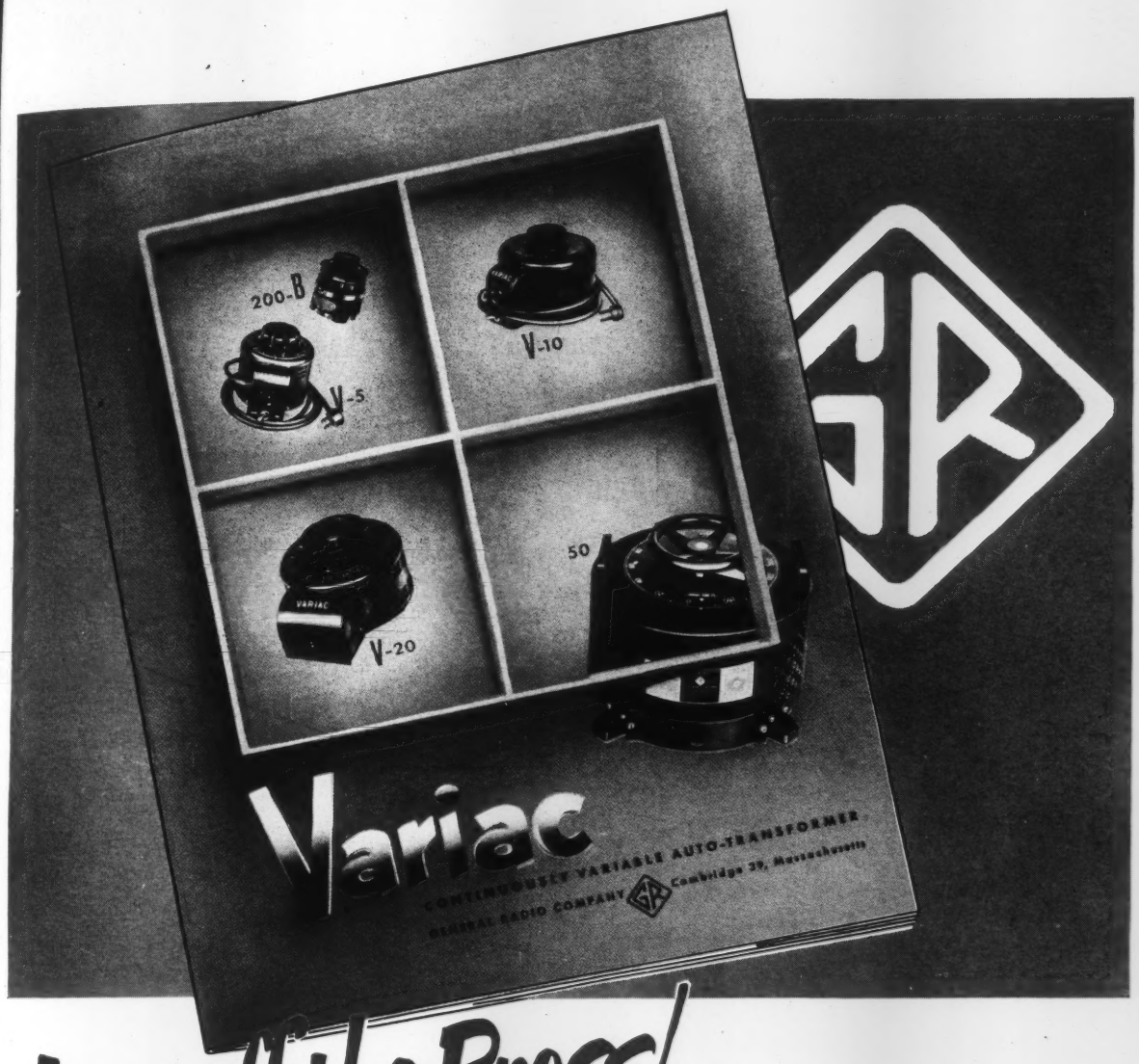

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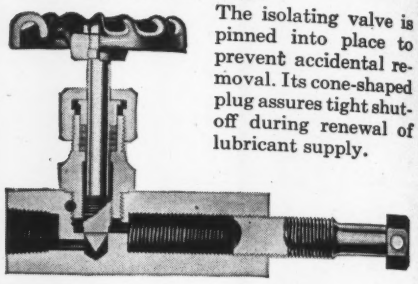

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Duplex Upper Stem Guide

One-Piece Bonnet

Packless Bellows Seal

Wide Variety of Discs

Reversibility in the Field

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Then check the other features of the valve . . . the Specially Designed Diaphragm, the Duplex Stem Guide, the One-Piece Bonnet, the Packless Bellows Seal, the wide variety of discs, the easy reversibility in the field.

Your comparison will prove that the Honeywell Series 700 has *all* of the features you look for in a fine valve.

It's available in a wide range of styles and sizes. For detailed information, write for a copy of Bulletin 700-2, or call in your local Honeywell engineer . . . he is as near as your phone.

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THE HOLE STORY
by Superior

Chapter 4

Putting the Squeeze on Tubing —to End Bends!

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In the normal course of tube drawing operations, unequal stresses are set up and the resultant tube has bends and bows which must be removed.

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To produce the world's best tubing we inspect and check many times, mechanically and metallurgically. We use microscopes to check grain structure, and keen-eyed inspectors to detect surface scratches, splits and pits. Pressure tests find any possible flaws in the walls. A continuing program keeps every Superior production worker aware of his part in the quality picture.

What does this mean to you?

It means you get fine small tubing that will do the toughest jobs better. Right now (because of Defense Orders and metal shortages) we may not be able to fill all of your tubing requirements, but it will pay you to check with your Superior distributor—he may have enough tubing in stock to help you. Always specify Superior Tubing and you'll always be right.

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West Coast: Pacific Tube Company, 5710 Smithway St., Los Angeles 22, Calif. UNderhill 0-1331.

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All analyses .010" to ⅜" O.D.
Certain analyses (.035" max. wall)
Up to 1⅜" O.D.

Specify
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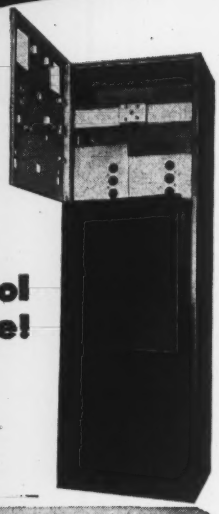
PANELS
by
FALSTROM



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Switchgear
Cabinet

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You can depend on Falstrom for experienced design and expert workmanship in the building of panelboards, switchboards, cubicles, instrument panels, control centers and switchgear housings. Falstrom service includes the planning and production of distinctive, finished housings with functional qualities that assure practical economical installations. Check with Falstrom, now. Fill out and mail handy coupon for details.

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Instruments
THE MAGAZINE OF
Measurement and Control

Vol. 24 OCTOBER 1951 No. 10

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By J. W. Peckham

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LEWIS PORTABLE PYROMETER POTENTIOMETERS

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IN MOVING VEHICLES

IN AIRCRAFT

IN THE LABORATORY

ACCURATE, DIRECT-READING, EASILY-OPERATED INSTRUMENTS, WITH ELECTRICAL COLD-JUNCTION COMPENSATION.

These potentiometers have been used for years by the leading motor car and aircraft manufacturers for proving-ground and flight-test work as well as in the laboratory.

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  Model 13PO2, with single temperature scale.
  Model 14PO (illustrated) with high and low temperature scales.
  Model 78PO with one temperature and one millivolt scale or two temperature scales, for different thermocouple materials.
- Housed in a sturdy hardwood case, approximately 11⅜" long, 10" wide and 7⅞" high. Weight approximately 17 lbs., shipping weight 20 lbs.
- For dependable temperature instrumentation, use these potentiometers with LEWIS leads, selector switches and thermocouples.

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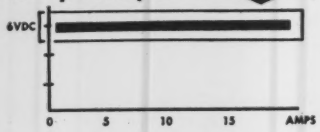
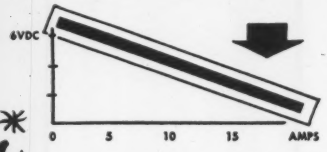
Manufacturers of Complete Temperature Measuring Systems for Aircraft

Problem •

What you require is



Your present DC source gives you



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Sorensen NOBATRONS provide regulated DC voltage, stabilized against LOAD changes as well as LINE fluctuations. A wide range of standard models are available in capacities from 7 to 200 VDC, 5 to 350 amps.

COMMON NOBATRON SPECIFICATIONS

Input Voltage range	95-130 VAC, single φ, 50-60 ~ High-current units 208/115, 3φ, 4-wire, wye.
Output voltage range	Adjustable ± 10% with rated accuracy, — 25% with lesser accuracy.
Regulation accuracy	± 0.2% from 1/10 to full load.
Ripple voltage	1% RMS. Time constant 0.2 seconds.

*Reg. U. S. Pat. Off. by Sorensen & Co., Inc.

Model E-6-15

SR-10

for maximum Flexibility the nobatron Ranger

Nobatron-RANGERS are continuously adjustable over wide output ranges, yet provide regulation accuracy of ± 0.25%. Other specifications are identical to those of the standard NOBATRONS.

Standard models with adjustable outputs of 3-30VDC, 3-135VDC, 200-300VDC.

Write for full information on Nobatrons, Nobatron-Rangers, and other Sorensen Isotronic† products.

†Isotronic is a trade-marked word pertaining to the electronic regulation and control of voltage, current, power, or frequency.

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Altadena, Calif., M. D. Pugh, 2721 N. Marengo Ave., Telephone Sycamore 7-2894

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London, W.C. 2, England. John C. N. Hughes, c/o T. G. Scott & Son, Ltd., 9 Arundel St., Telephone Temple Bar 1942

COVER PICTURE

The Continuous Automatic Lube Oil Blender pictured on our cover is in operation at Sun Oil Company's new Marcus Hook Refinery. The blending system, which incorporates Hammel-Dahl valves, was designed by Proportioneers, Inc. The system reduces complex batch compounding to automatic continuous blending. A wide variety of additives and base stocks can be compounded and proportioned accurately and automatically. The blender provides for presetting and controlling component and additive ratios. Facilities are provided for quickly adjusting total rate to production requirements without affecting the percentage relationship of the ingredients.

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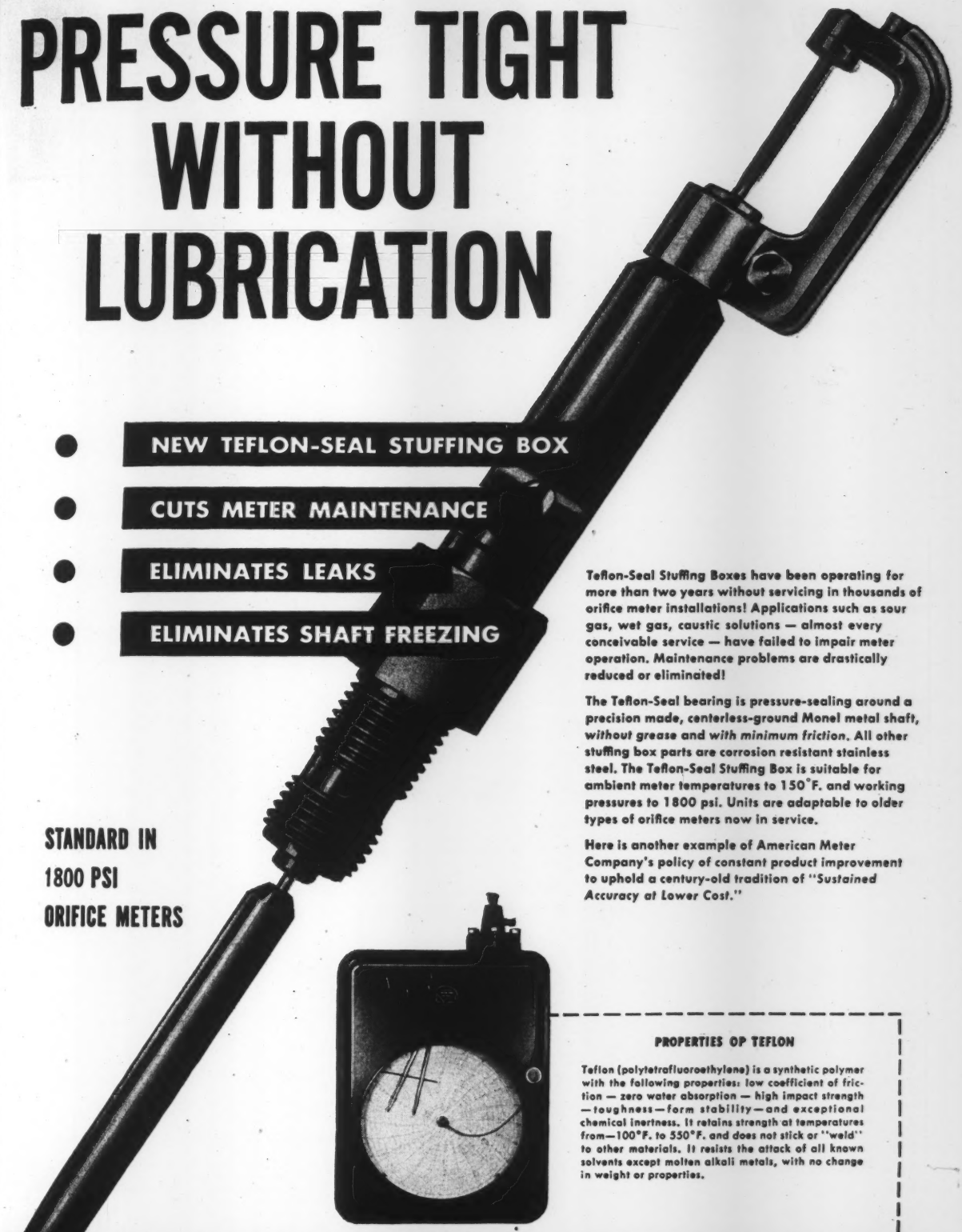
- ELIMINATES LEAKS
- ELIMINATES SHAFT FREEZING

STANDARD IN 1800 PSI ORIFICE METERS



Teflon-Seal Stuffing Boxes have been operating for more than two years without servicing in thousands of orifice meter installations! Applications such as sour gas, wet gas, caustic solutions — almost every conceivable service — have failed to impair meter operation. Maintenance problems are drastically reduced or eliminated!

The Teflon-Seal bearing is pressure-sealing around a precision made, centerless-ground Monel metal shaft, *without grease* and *with minimum friction*. All other stuffing box parts are corrosion resistant stainless steel. The Teflon-Seal Stuffing Box is suitable for ambient meter temperatures to 150°F. and working pressures to 1800 psi. Units are adaptable to older types of orifice meters now in service.

Here is another example of American Meter Company's policy of constant product improvement to uphold a century-old tradition of "*Sustained Accuracy at Lower Cost.*"

PROPERTIES OP TEFLON

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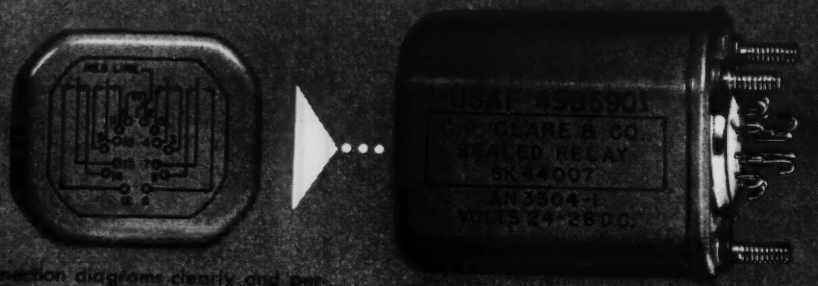
AMERICAN METER COMPANY

Plus Values of CLARE when unfailing



Connection diagrams clearly and permanently imprinted by silk screen process. Not just stamped upon top of enclosure.

Clare hermetically sealed relay with solder terminals.

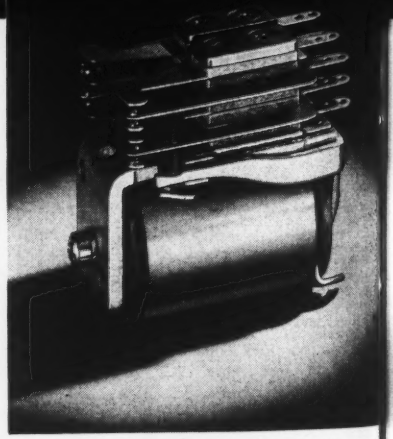
Same relay with AN Plug Connector

This small CLARE Type "R" Relay supplies many special features responsible for the outstanding performance of these new "AN" approved relays.

The operating "heart" of these two new hermetically sealed relays is the CLARE Type "R" Relay which is characterized by unusual sensitivity and extremely long life.

It combines the advantages of a telephone-type relay with the small size, light weight and resistance to vibration required to meet the rigid demands of aircraft service. The Type "R" retains in an improved form the reed armature suspension which discerning engineers have come to recognize as one of the subtler reasons for the superior performance of CLARE Type "K" relays.

The Type "R" is $1\frac{1}{16}$" long, $1\frac{3}{64}$" high and 1" in width. It weighs approximately 2 ounces. Coil may be single or double-wound; armature, single or double-arm; operating voltage up to 230 volts d-c.



CLARE Type "R" RELAY

CLARE RELAYS . . .

RELAYS make them 1st choice performance is a "must".

These two hermetically sealed CLARE RELAYS not only meet, but surpass, stringent requirements for airborne military use.

When the safety of a plane costing perhaps millions of dollars, and the priceless lives of its crew, may depend upon the unfailing performance of a relay, the *plus values* of a CLARE RELAY are of tremendous importance.

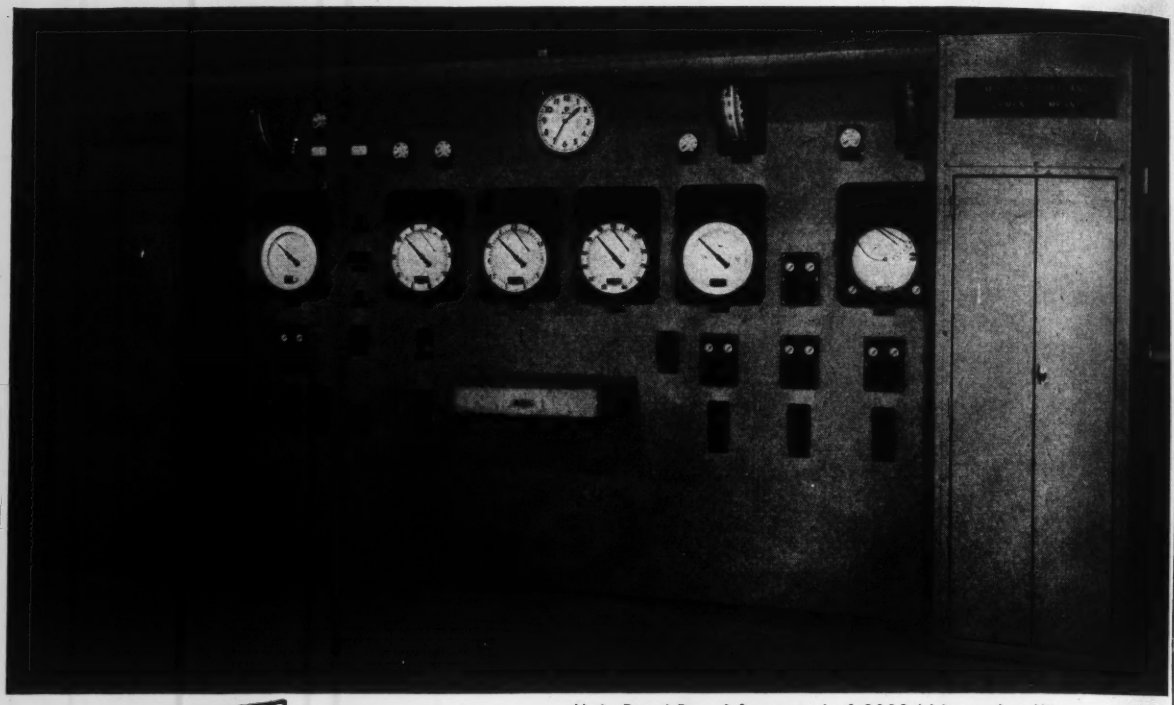
These two hermetically sealed CLARE Type "R" Relays were designed to meet airborne-service specifications so difficult and exacting that several months were required to run the rigid performance tests. They meet the specifications in every particular—and even *exceed* them in many significant respects!

The CLARE standard leak test, for example, made with a mass spectrometer, is much more stringent than the immersion test the relays are asked to meet. The resistance to vibration inherent in the design of the CLARE Type "R" Relay is an important factor in enabling these relays to exceed required specifications by a wide margin.

Outstanding Operational Features

- CLARE Type "R" Relay provides uncommonly wide contact gaps and heavy contact pressures without requiring any more operating power than ordinary relays of the same size.
- Powerful coil and generous use of iron in close-coupled magnetic structure enables these relays to pull in at 64% of nominal operating voltage at 85° C. and yet draw no more than 0.120 amp. on 28 volts at 25° C.
- Leakage: Terminal-to-terminal or terminal-to-frame resistance, 10,000 megohms.
- Cover is rolled and crimped over edge of base in a hydraulic press; does not depend on solder seam for mechanical strength.

Clare sales engineers are located in principal cities. Call on them or write: C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials, Ltd., Toronto 13. Cable Address: CLARELAY.



Main Panel Board for control of 3000 bbl per day Kiln at Missouri Portland Cement Company, St. Louis, Missouri.

3 Ways Better

...Bailey Control for Rotary Kilns

Bailey Control for Rotary Kilns gives you better performance three ways:

1. Economical Operation
2. Uniform Quality of Product
3. Reduced Maintenance

These are advantages which can be achieved when all phases of kiln operation are coordinated to work together as a team. Here's how Bailey Kiln Control can help you get all three.

ECONOMICAL OPERATION

With Bailey Combustion Control you can be certain that you are getting maximum product for every unit of fuel you burn. Bailey Control closely guards the Fuel-Air Ratio, Hood Draft, Fuel Feed, Clinker Cooling and the Temperature of Air for Combustion.

UNIFORM QUALITY OF PRODUCT

Bailey Instruments and Controls can help you achieve a uniform high grade product. Measurements of temperatures, kiln speed, combustibles content, and oxygen content can be transmitted to recorders on centrally located control boards like the one shown. There is no sacrifice of accuracy or speed of response. High temperature alarm contacts may also be provided with Bailey Pyrometers as a further aid in achieving optimum uniformity of product.

REDUCED MAINTENANCE

By maintaining uniform temperatures and excess air conditions in the kiln, Bailey Controls help to reduce to a minimum costly refractory repairs and wear and tear on auxiliary equipment.

Bailey Meter Company has a staff of engineers who are experts in the control of rotary kilns. Assure yourself of optimum kiln performance. Let one of these men help plan your Kiln Control System. P-22

BAILEY METER COMPANY

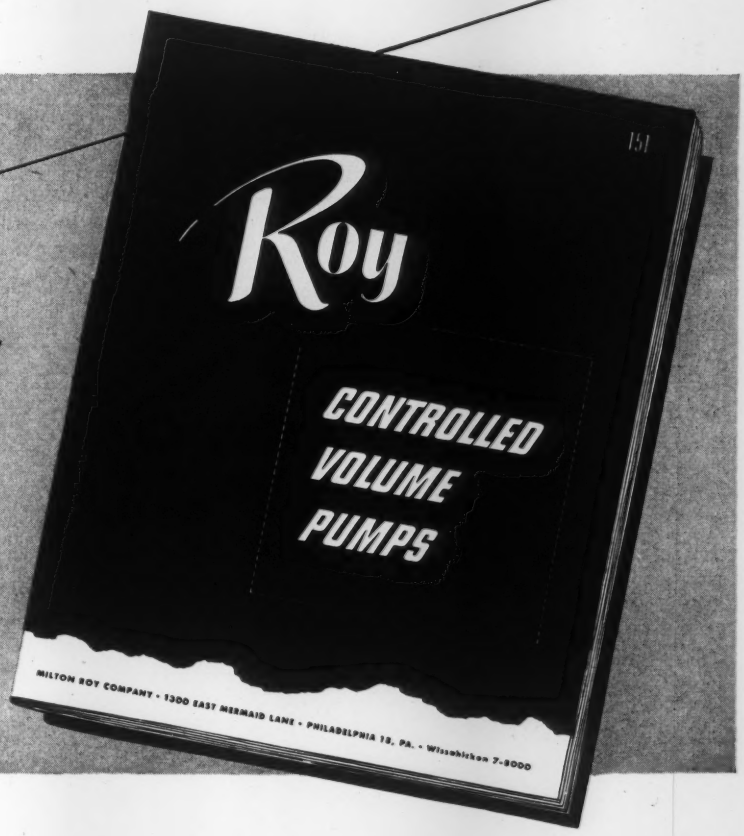
1041 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Processing

TEMPERATURE
PRESSURE
% OXYGEN
% COMBUSTION
FLOW
LEVEL
DENSITY
RATIO

CONTROLLED VOLUME PUMPING

This Milton Roy Bulletin No. 151 Gives You COMPLETE DETAILS



Bulletin No. 151 is filled with information on controlled volume pumping. Here are a few of the many important details you'll find in the book:

- an explanation of controlled volume pumping.
- a description of what controlled volume pumping can do for you—what it does for others in the chemical, textile, petroleum, pulp and paper, paint, food and beverage, water treatment, pharmaceutical, and brewing industries and in instrumentation, pilot plants and laboratories.
- a description of how Milton Roy Controlled Volume Pumps give users maximum benefits; how any desired rate of delivery, from zero to full capacity, can be maintained with accuracy; how deliveries as low as 3 milliliters per hour can be held with precision; how difficult-to-pump materials, such as slurries, viscous liquids, solids in suspension, etc., are readily handled.
- 4 pages of color charts which show in dramatic "traffic-light" style the relative corrosion resistance of materials of construction to over 170 chemicals. These valuable reference charts summarize industry-wide data.
- a description of the features that make Milton Roy Controlled Volume Pumps perform flawlessly on services where no other pump has filled the need.

If your operations call for pumping a controlled volume of liquid in amounts as much as 50 gallons per *minute* or as little as 3 milliliters per *hour,* you'll find this book extremely valuable.

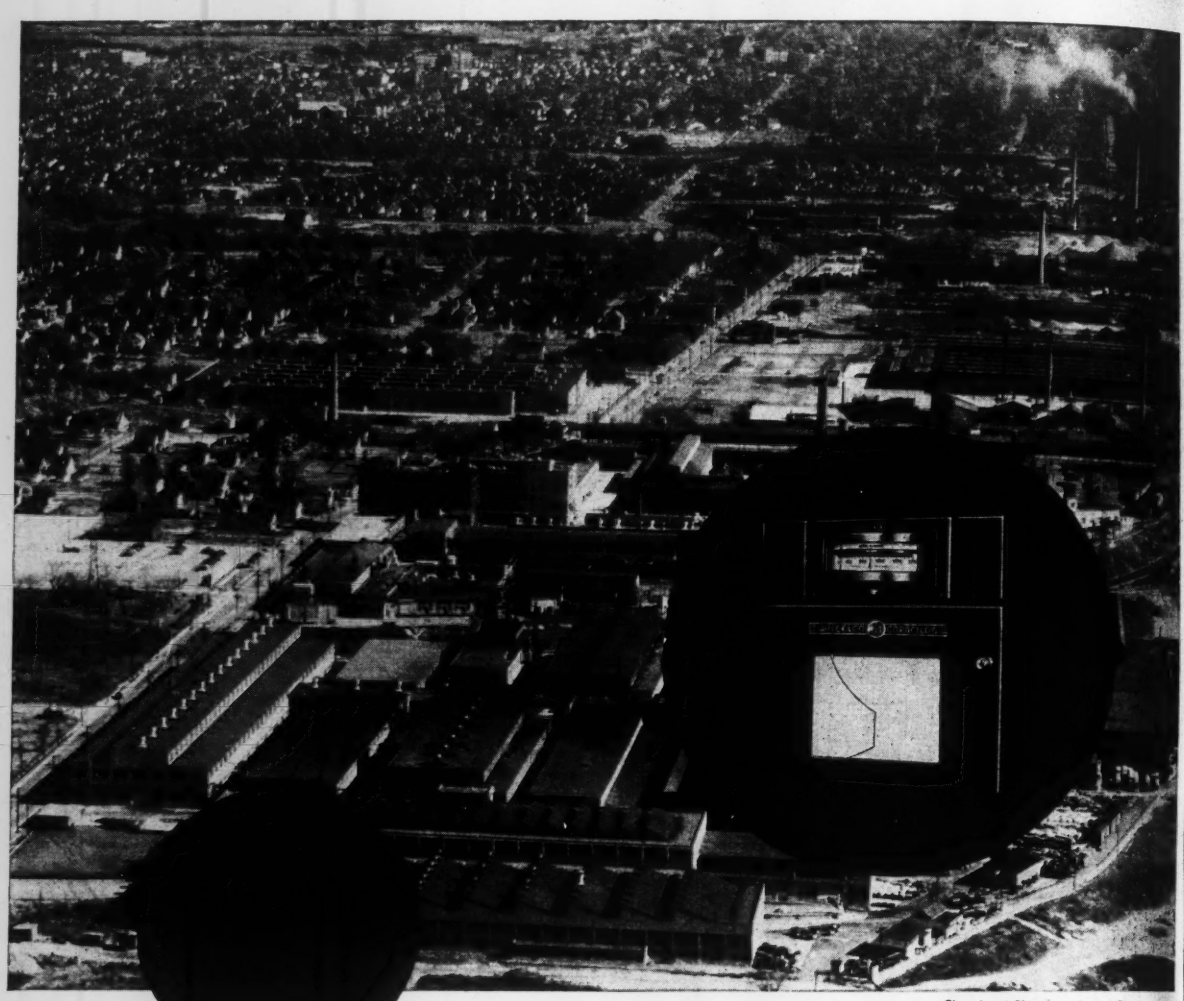
For your free copy of the 24-page, 2-color Milton Roy Bulletin No. 151, write or call the Milton Roy representative listed in your telephone directory. Or, if you prefer, write direct to us.

WITH THE EXCLUSIVE STEP-VALVE DESIGN

MILTON Roy COMPANY

1309 EAST MERMAID LANE, PHILADELPHIA 18, PA.

MANUFACTURERS OF CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS



Cleveland Photo — Aerial Surveys, Inc.

the wheelco recorder

In Cleveland factories, whether it's tin cans or the food in the cans—delicate hair springs or giant gears—fine ceramic ware or sturdy milk bottles—colorful auto paint or engine oil—the Wheelco Recorder accurately writes a diverse production history. For invaluable assistance in your own plant, follow the lead of progressive production men—for measurement, indication, control and recording of electrically measurable variables, specify the economical Wheelco Capacilog, deflection type, strip chart recorder.

Yes, for accuracy to ¼ of 1% of total scale, specify the Wheelco Capacilog. Capacilogs are built for use with thermocouples and resistance thermometer measuring elements; as single or multipoint recorders, and with six different control combinations including pneumatic and electric proportioning types. Remember, in Cleveland and throughout the nation where production records are set, they're made and kept on Wheelco recorders.

Assembly line production and simplicity of construction make it possible to deliver most models within 20 days.

Wheelco Instruments Company, 847 W. Harrison Street, Chicago 7, Illinois

wheelco *electronic controls*

Today's speeds demand electronic gunnery

Today, with interceptors capable of closing in at blinding speeds, the problem of effective gunnery for bomber protection becomes increasingly acute. Split-second tracking, computation and firing are demanded – and complex, compact, light-weight electronic instruments furnish the answer. Arma – working closely with our Armed Forces since 1918 – has supplied the outstanding engineering, imaginative design and precision manufacture that play a leading part in producing these miraculous instruments.

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254 36th Street, Brooklyn 32, N. Y.
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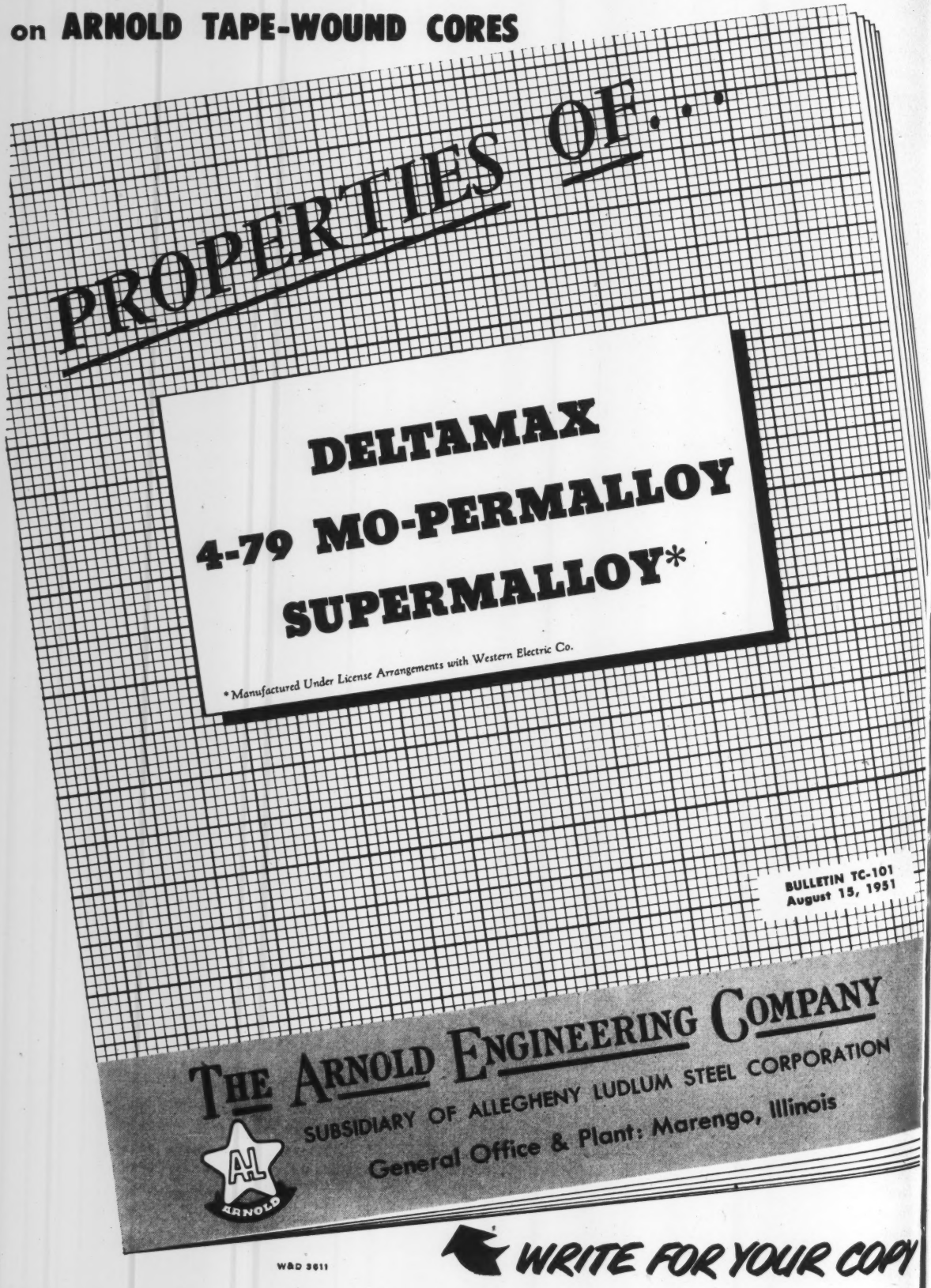
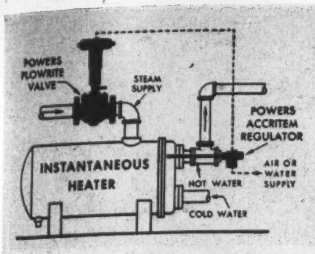
on ARNOLD TAPE-WOUND CORES





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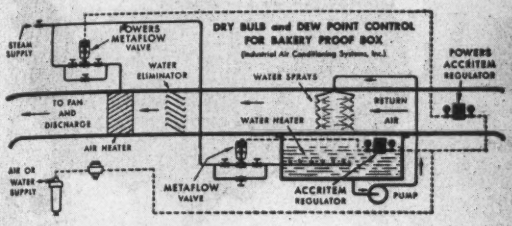
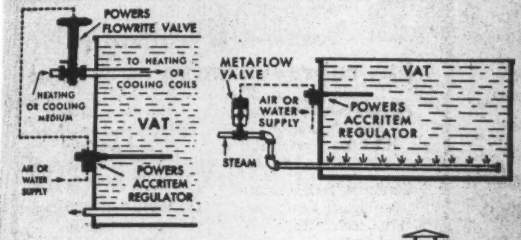
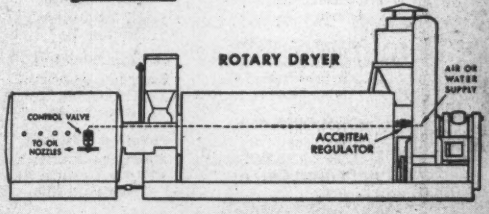
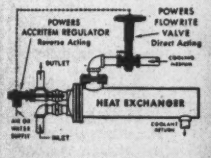
ACCRITEM REGULATOR

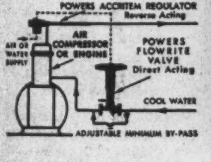
Only a few of many uses

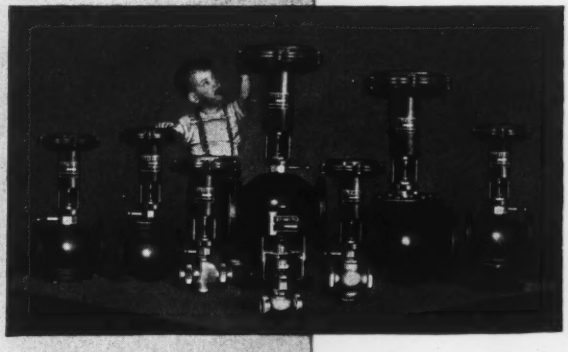


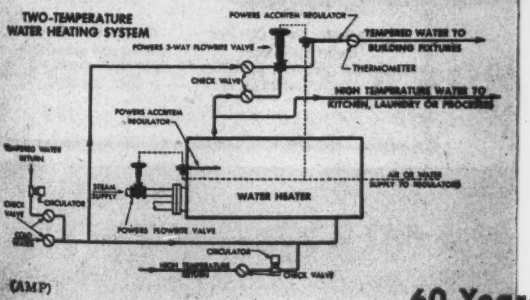












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Use Accritem Regulators to control diaphragm operated valves or dampers. They save labor, stop losses caused by over-heating and have the following—

IMPORTANT ADVANTAGES

- ***Adjustable Sensitivity*** and over-heat protection.
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- ***Simple, Rugged Construction*** withstands vibration and insures many years of reliable service.
- ***Temperature Ranges*** 50 to 250° F. and 150 to 350° F.
- ***Easy to Install*** Requires 15 lb. supply of compressed air or water for its operation.
- ***Small Size***—regulator head is only 2⅞″ x 3⅝″, sensitive bulb is 12″ long with ½″ I.P.S. connection.

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FLOWRITE and METAFLOW
Diaphragm Valves
controlled by a POWERS
ACCRITEM HEAT REGULATOR
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60 Years of Temperature and Humidity Control

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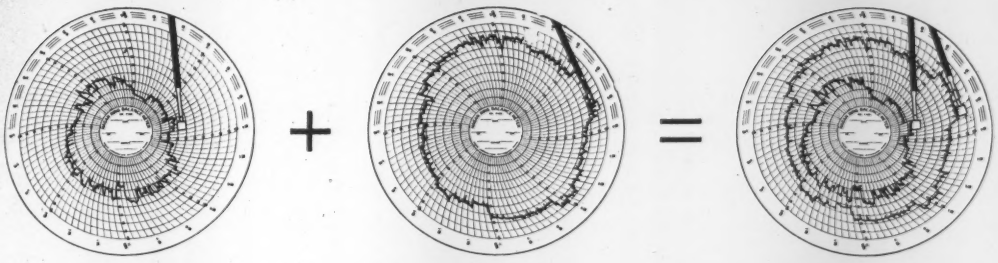


Dependable Measurement

is assured with HAGAN

RING BALANCE METERS

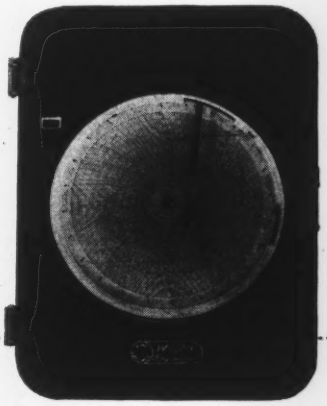
COST DISTRIBUTION is easy when the sum of individual flows equals the total flow —and records and totalized flows *are dependable* when made by Hagan Ring Balance Meters.

STANDARD ASSEMBLIES are available for measuring flow differentials up to 420″ water column at 3000 psig.

DUAL METER ASSEMBLIES give two records of flow differentials, each up to 140″ water column at 3000 psig.

AUTOMATIC COMPENSATION for pressure or temperature, or both, may be added.

For more information about Hagan Ring Balance Meters, clip the coupon.



FEATURES OF ALL HAGAN RING BALANCE METERS INCLUDE:

- ★ **No Stuffing Boxes**
- ★ **Mercury level not critical**
- ★ **Dead-weight calibration under full static pressure**
- ★ **Full scale differential range adjustable over 7-to-1.**

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
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Please send me further information on Hagan Ring Balance Meters. I am particularly interested in.....

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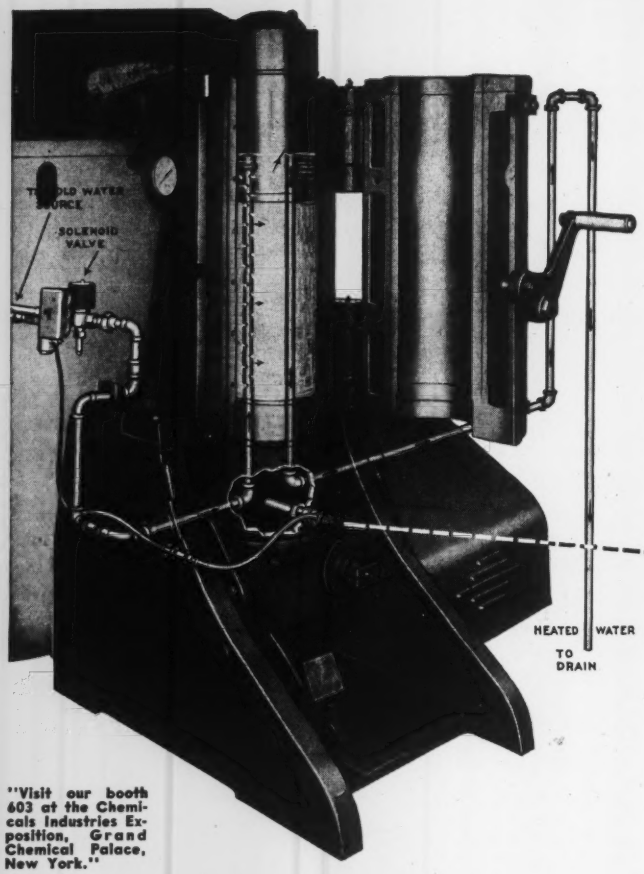
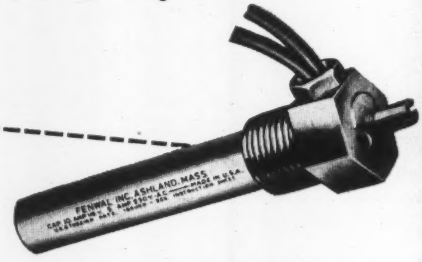
Multi-purpose THERMOSTAT radically reduces printing plate rejects





CUTAWAY DRAWING shows how Fenwal THERMOSWITCH controls temperature of cooling jacket in the Tubular Plate Caster.

"Visit our booth 603 at the Chemicals Industries Exposition, Grand Chemical Palace, New York."

The Tubular Plate Caster machine used in the production of printing plates at the Nordmann Printing Company, 4210 Chippewa St., St. Louis was the seat of considerable trouble when it was water cooled by a hand valve. If too much cold water was run into the cooling jacket, the temperature was reduced so fast that the plates shrank. If too little water entered, the temperature remained too hot and plates became porous. In either case, plates had to be remelted and recast with resultant loss of labor and time.

The problem was solved by replacing the hand valve with a solenoid water valve and installing a low-cost Fenwal THERMOSWITCH thermostat. This unit opens the valve when water gets too hot. Cold water then flows in, hot water drains off, and valve is shut when proper water temperature is reached. *As a result, rejects have been practically eliminated.*

This is but one of many ways in which easy-to-install, easy-to-maintain Fenwal THERMOSWITCH Units effectively control variables where heat is a factor. Their unique principle of operation consists of an activating control element that is a single-metal shell. This shell expands or contracts *instantaneously* with temperature changes, making or breaking the totally enclosed electrical contacts.

Fenwal THERMOSWITCH thermostats can no doubt help you in your own processing. Find out how by mailing the coupon today.

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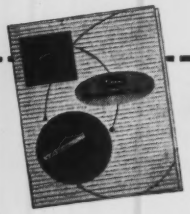
THERMOSWITCH

The Precision, Multi-Purpose, Thermostat Control

SENSITIVE . . . but only to heat



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Just fill in coupon and mail . . . no obligation.

FENWAL, INCORPORATED, 1710 Pleasant St., Ashland, Mass.
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Company .....

Street .....

City ..... Zone ..... State .....

I am chiefly interested in the applications checked:

- ☐ Heating
- ☐ Cooling
- ☐ Humidity Control or Detection
- ☐ Alarm (over-temperature, under-temperature)
- ☐ Vapor Control
- ☐ Timing (thermal)
- ☐ Radiant Heat Control
- ☐ Pressure Control (by controlling vapor temperature)

OTHER (Please fill in your special requirements) .....

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strain analysis improves design...

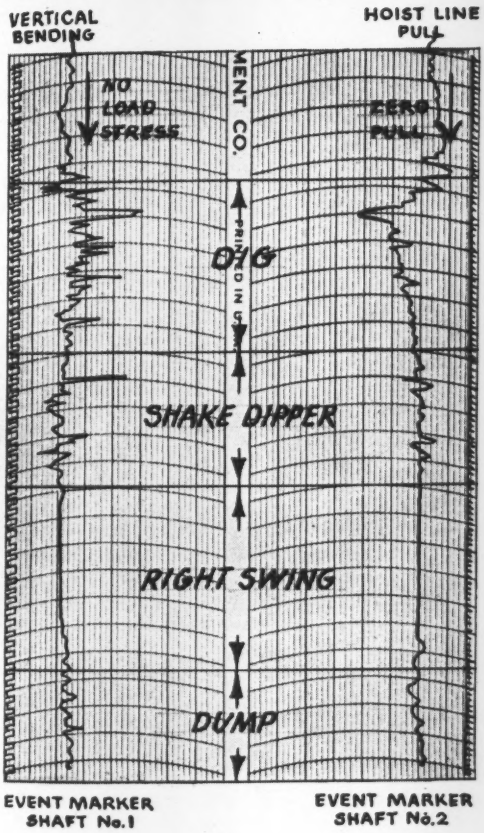
BRUSH ANALYZER GIVES COMPLETE DATA...IN WRITING

● If the boom on an excavator is "over-designed", needless weight is added and steel is wasted. If the boom is "under-designed", failure may result.

That's why designers of the Marion Power Shovel Company get design facts from excavators in actual operation. With strain gages mounted on the boom, the hoist line pull on the shovel and the vertical bending of the boom are recorded automatically with a Brush two-channel Recording Analyzer. Event markers, recording on the same graph, indicate comparative rpm of different shafts.

Result—data not previously known has led to an improved design of Marion Excavators, and the saving of weight in the booms. Despite the severe operating conditions—for instruments—the Brush Analyzer continues to give satisfactory service.

It will pay you to investigate Brush Analyzers for studies of strains, displacements, light intensities, temperatures, surfaces, d-c or a-c voltages or currents, and other static or dynamic conditions. Write for full information. The Brush Development Company, Department A-13, 3405 Perkins Avenue, Cleveland 14, Ohio, U. S. A. *Canadian Representatives:* A. C. Wickman (Canada) Ltd., P. O. Box 9, Station N, Toronto 14, Ontario.



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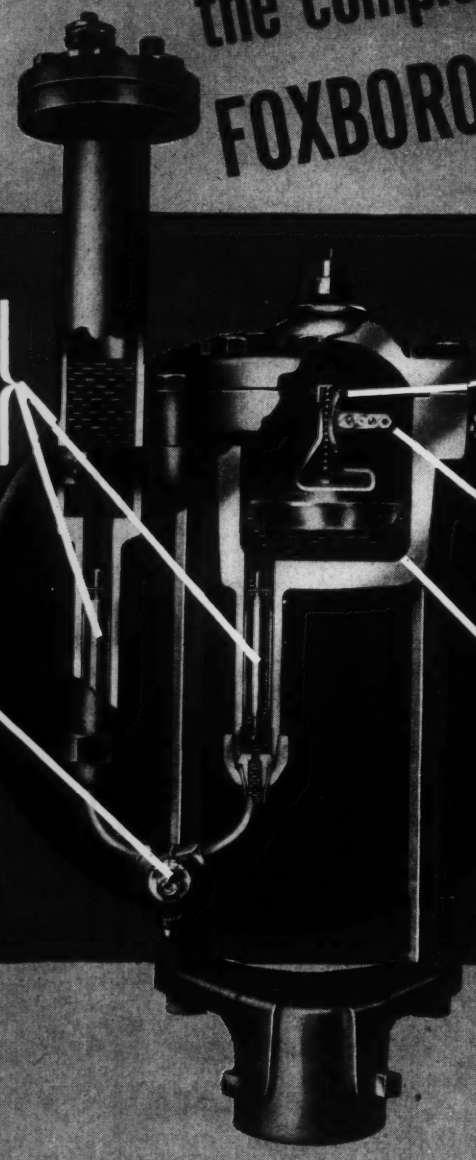
BRUSH RECORDING ANALYZER

THE Brush DEVELOPMENT COMPANY

PIEZOELECTRIC CRYSTALS AND CERAMICS • MAGNETIC RECORDING • ELECTROACOUSTICS • ULTRASONICS • INDUSTRIAL & RESEARCH INSTRUMENTS

ANNOUNCING

New Basic Advances in the complete line of FOXBORO FLOW METERS!



NEW Check Floats with redesigned guides, ball plug and seat. Insure perfect seating every time! Submerged in mercury for complete protection against frosting and fouling.

NEW U-Bend and Damping Plug Assembly. Easy to make up tight every time because of self-aligning all-welded construction. No gasket needed. Replaceable seats. Damping plug fully adjustable under pressure. Directed drain for mercury at lowest point.

NEW Segmental Drive Assembly with stainless steel ball chain that insures free travel of float, and with positive collet-type bearing shaft clamp. Assembly also available in Type 28 Meters with complete ambient temperature compensation —an exclusive new Foxboro feature.

NEW Pressure-Seal Bearing. Revolutionary ring seal gives unequalled freedom from friction, and complete freedom from leaks, at any working pressure. Factory-lubricated—no lubricator required. Shaft and bearing *both* of Type 316 stainless steel.

NEW Compact Float Chamber gives greater accessibility for easier, quicker cleaning.

All parts freely interchangeable. Easy substitution of range chambers.

FOXBORO

REG. U. S. PAT. OFF.

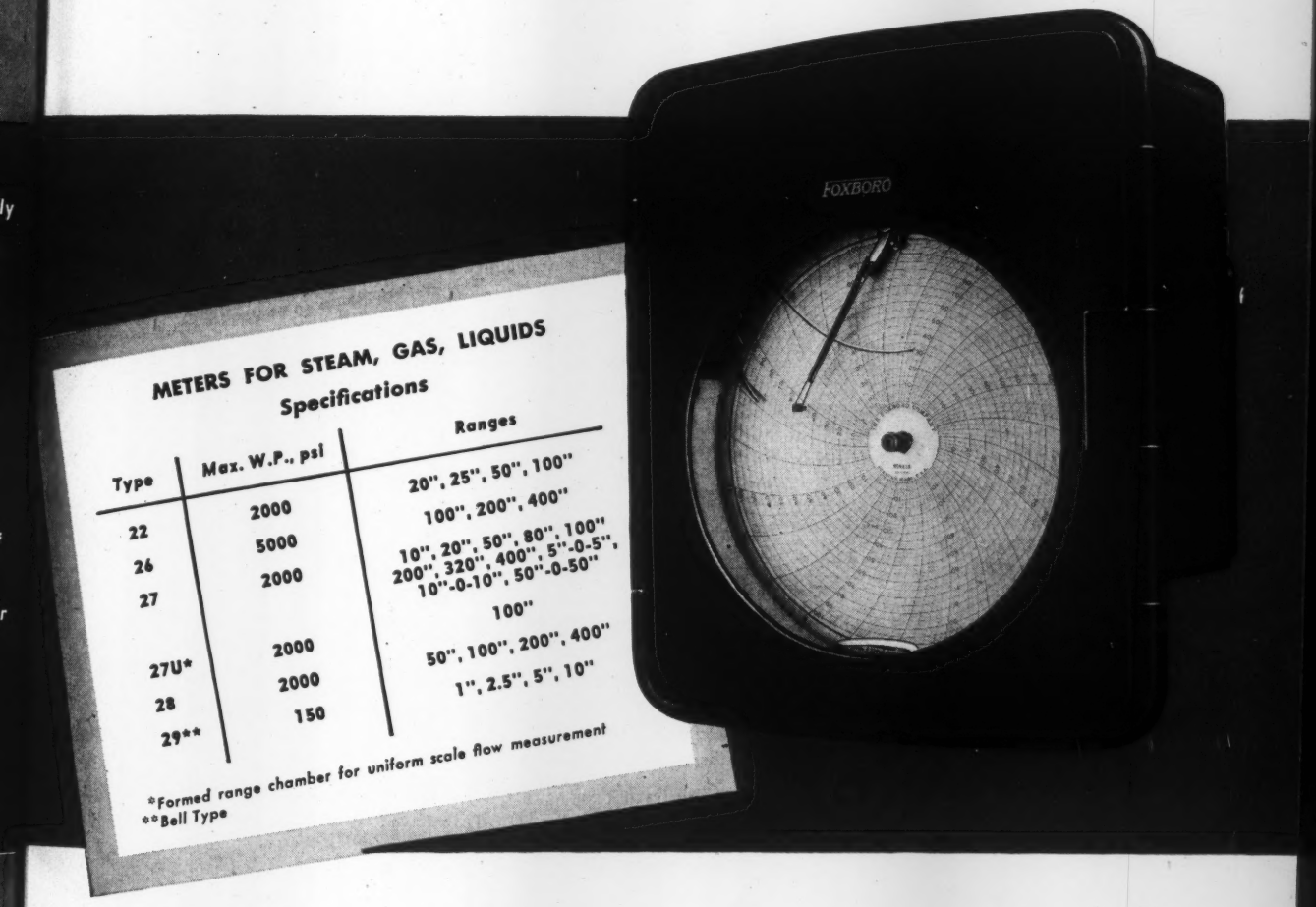
FACTORIES, IN THE UNITED STATES, CANADA AND ENGLAND

Higher sustained accuracy, less maintenance than ever before!

Outstanding improvements in every basic detail of differential meter design now afford a new complete line of Foxboro Flow Meters that set an unprecedented standard of dependable accuracy.

In addition to the important features outlined on the opposite page, these new meters retain all the uniquely advantageous features of the previous Foxboro line, including large floats with long travel for added power; and floats located in high pressure chamber to minimize ambient temperature effects. The combined result is practical metering performance that's farther ahead of the field than ever before . . . in maintenance-freedom as well as sustained accuracy.

Check up on all the advantages of the new Foxboro Flow Meters. Available in round or rectangular cases . . . as indicators, recorders, controllers or transmitters . . . with or without integrators. There's a type for every metering problem. Write for New Bulletin 460. The Foxboro Company, 4610 Neponset Ave., Foxboro, Mass., U.S.A.



METERS FOR STEAM, GAS, LIQUIDS
Specifications

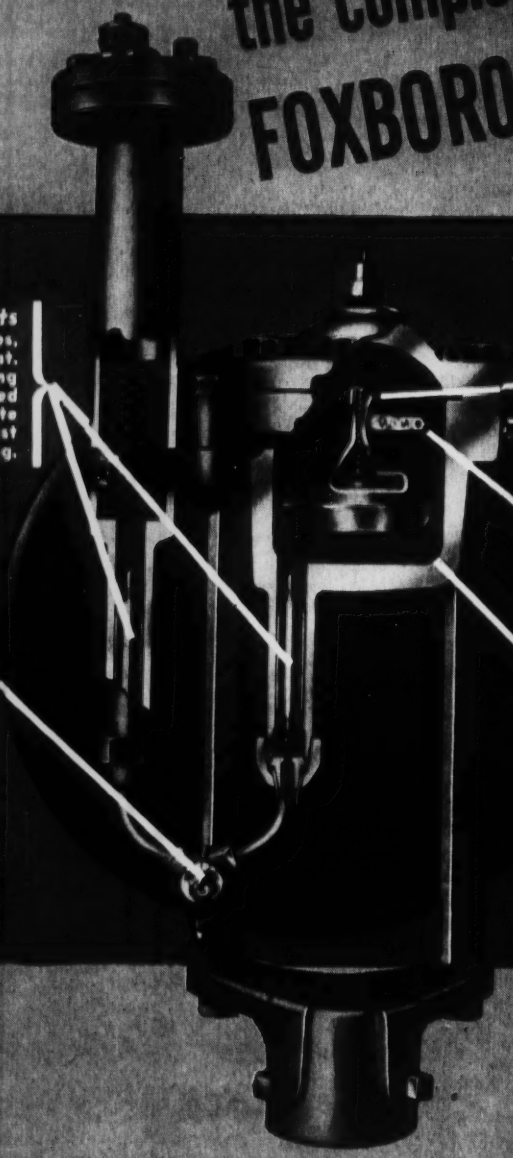
Type	Max. W.P., psi	Ranges
22	2000	20", 25", 50", 100"
26	5000	100", 200", 400"
27	2000	10", 20", 50", 80", 100", 200", 320", 400", 5"-0-5", 10"-0-10", 50"-0-50"
27U*	2000	100"
28	2000	50", 100", 200", 400"
29**	150	1", 2.5", 5", 10"

*Formed range chamber for uniform scale flow measurement
**Bell Type

. First in FLOW METERS

ANNOUNCING

New Basic Advances in the complete line of FOXBORO FLOW METERS!



NEW Check Floats with redesigned guides, ball plug and seat, insure perfect seating every time! Submerged in mercury for complete protection against frosting and fouling.

NEW U-Bend and Damping Plug Assembly. Easy to make up tight every time because of self-aligning all-welded construction. No gasket needed. Replaceable seats. Damping plug fully adjustable under pressure. Directed drain for mercury at lowest point.

NEW Segmental Drive Assembly with stainless steel ball chain that insures free travel of float, and with positive collet-type bearing shaft clamp. Assembly also available in Type 28 Meters with complete ambient temperature compensation —an exclusive new Foxboro feature.

NEW Pressure-Seal Bearing. Revolutionary ring seal gives unequalled freedom from friction, and complete freedom from leaks, at any working pressure. Factory-lubricated—no lubricator required. Shaft and bearing both of Type 316 stainless steel.

NEW Compact Float Chamber gives greater accessibility for easier, quicker cleaning.

All parts freely interchangeable. Easy substitution of range chambers.

FOXBORO

REG. U.S. PAT. OFF.

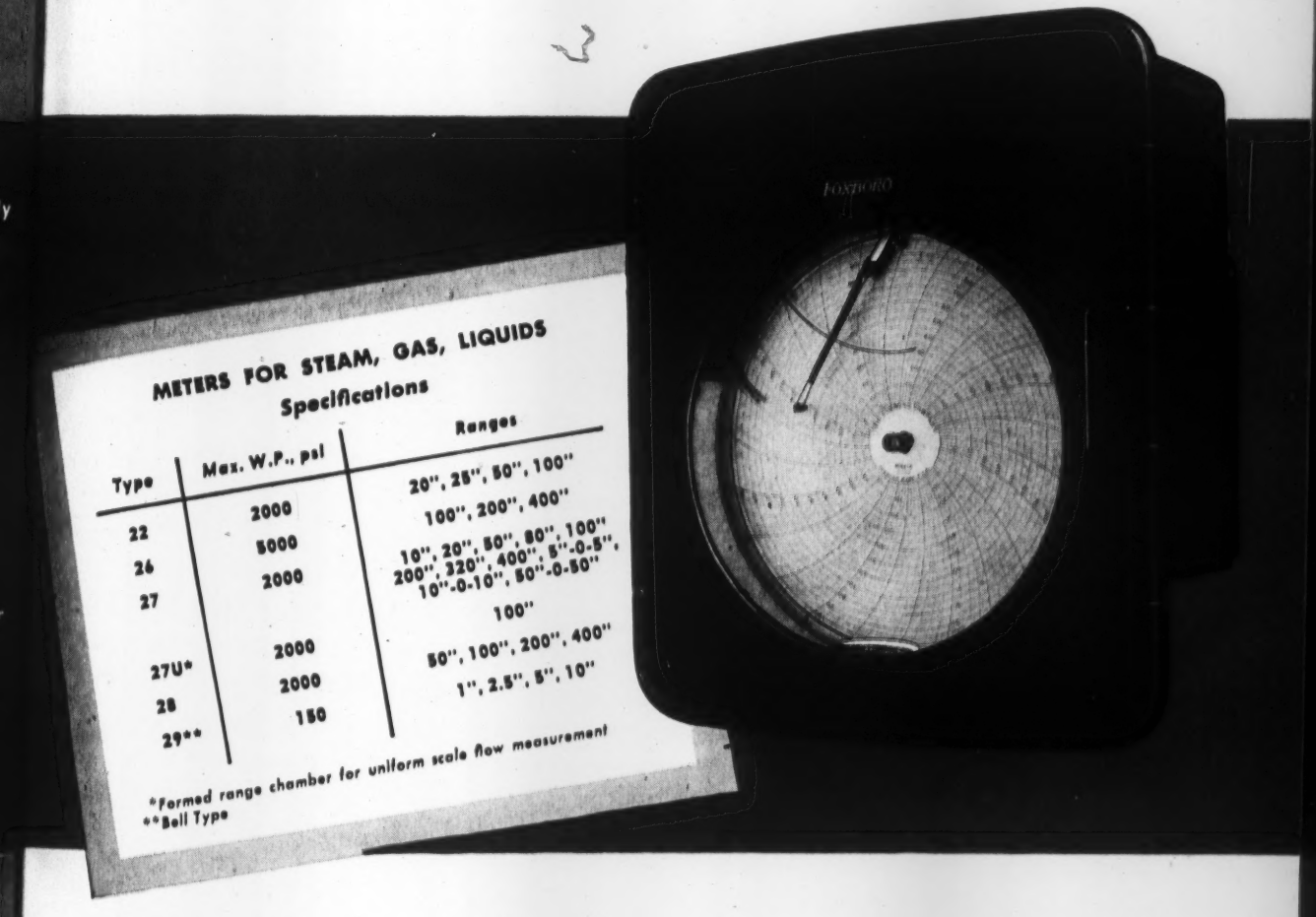
FACTORIES, IN THE UNITED STATES, CANADA AND ENGLAND

Higher sustained accuracy, less maintenance than ever before!

Outstanding improvements in every basic detail of differential meter design now afford a new complete line of Foxboro Flow Meters that set an unprecedented standard of dependable accuracy.

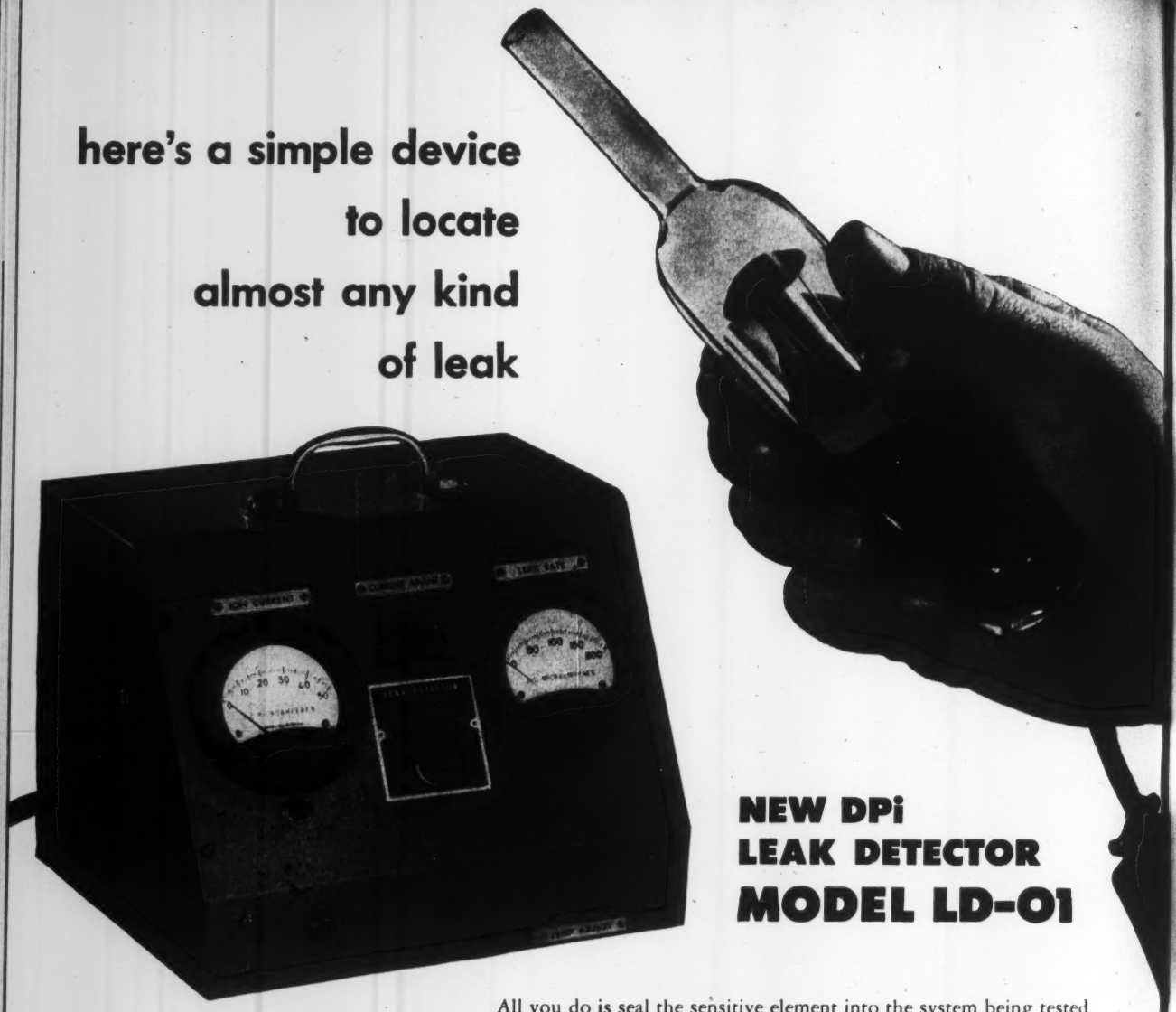
In addition to the important features outlined on the opposite page, these new meters retain all the uniquely advantageous features of the previous Foxboro line, including large floats with long travel for added power; and floats located in high pressure chamber to minimize ambient temperature effects. The combined result is practical metering performance that's farther ahead of the field than ever before . . . in maintenance-freedom as well as sustained accuracy.

Check up on all the advantages of the new Foxboro Flow Meters. Available in round or rectangular cases . . . as indicators, recorders, controllers or transmitters . . . with or without integrators. There's a type for every metering problem. Write for New Bulletin 460. The Foxboro Company, 4610 Neponset Ave., Foxboro, Mass., U.S.A.



. . . First in FLOW METERS

here's a simple device to locate almost any kind of leak



NEW DPi LEAK DETECTOR MODEL LD-01

All you do is seal the sensitive element into the system being tested and bring the interior to a pressure of 10 mm Hg or less. Then you direct a small jet of harmless Freon Gas at suspected spots and watch the meter. It's as simple as that, and sensitivity is high enough even where one-millionth of atmospheric pressure is to be maintained.

It works like this: The sensitive element contains a heated platinum anode and a cold cathode with relatively low voltage between them. The tendency of hot platinum to emit positive ions is enormously stimulated by infinitesimal traces of halogens or their compounds. The circuit to accomplish all this uses only three standard radio tubes and operates from your 115-v a-c lighting circuit.

For full information write *Distillation Products Industries,* Vacuum Equipment Department, 727 Ridge Road West, Rochester 3, N. Y. (Division of Eastman Kodak Company).

DPi

high vacuum research and engineering

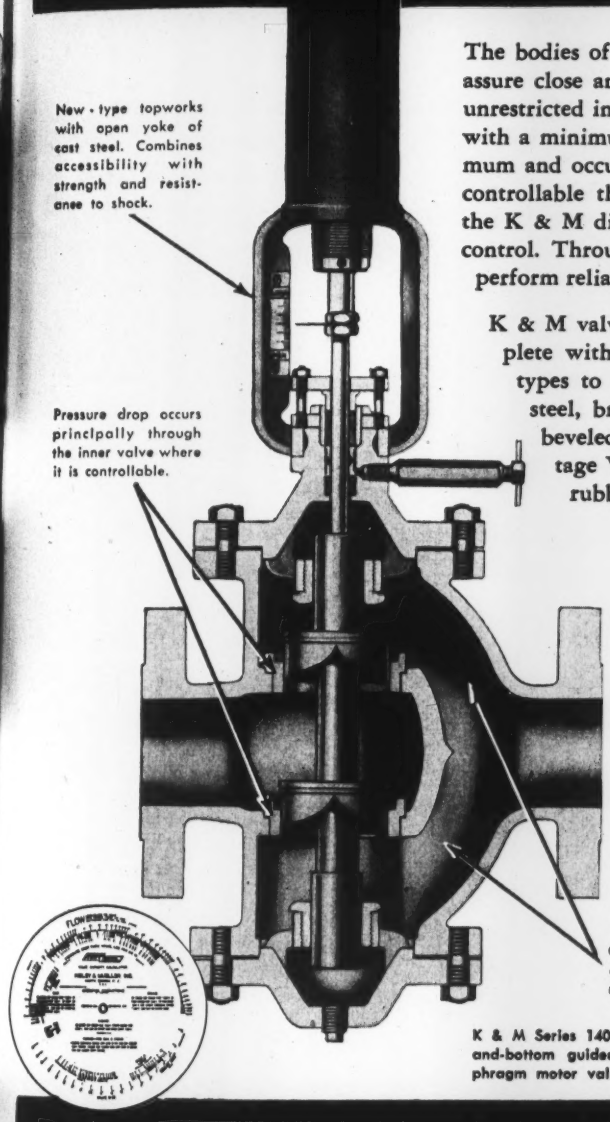
Also . . . high vacuum equipment . . . distilled monoglycerides . . . more than 3400 Eastman Organic Chemicals for science and industry

The Control Valves

DESIGNED ESPECIALLY FOR INSTRUMENTATION

New-type topworks with open yoke of cast steel. Combines accessibility with strength and resistance to shock.

Pressure drop occurs principally through the inner valve where it is controllable.



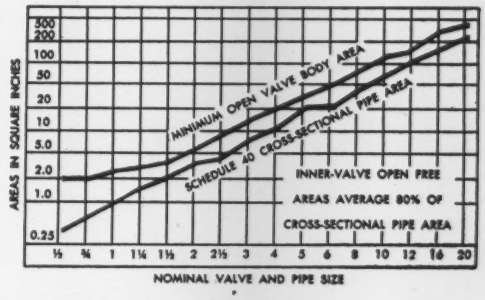
Over-size, streamlined body areas reduce turbulence and friction to a minimum and assure smooth, maximum flow.

K & M Series 1400 top-and-bottom guided diaphragm motor valve.

The bodies of K & M Control Valves are especially designed to assure close and positive control by instrumentation. They have unrestricted inlet and discharge passages and permit smooth flow with a minimum of turbulence. Pressure drop is held to a minimum and occurs principally through the inner valve where it is controllable through the full valve travel. The construction of the K & M diaphragm motors assures extreme precision in this control. Throughout, K & M Control Valves are engineered to perform reliably in *the most exacting applications.*

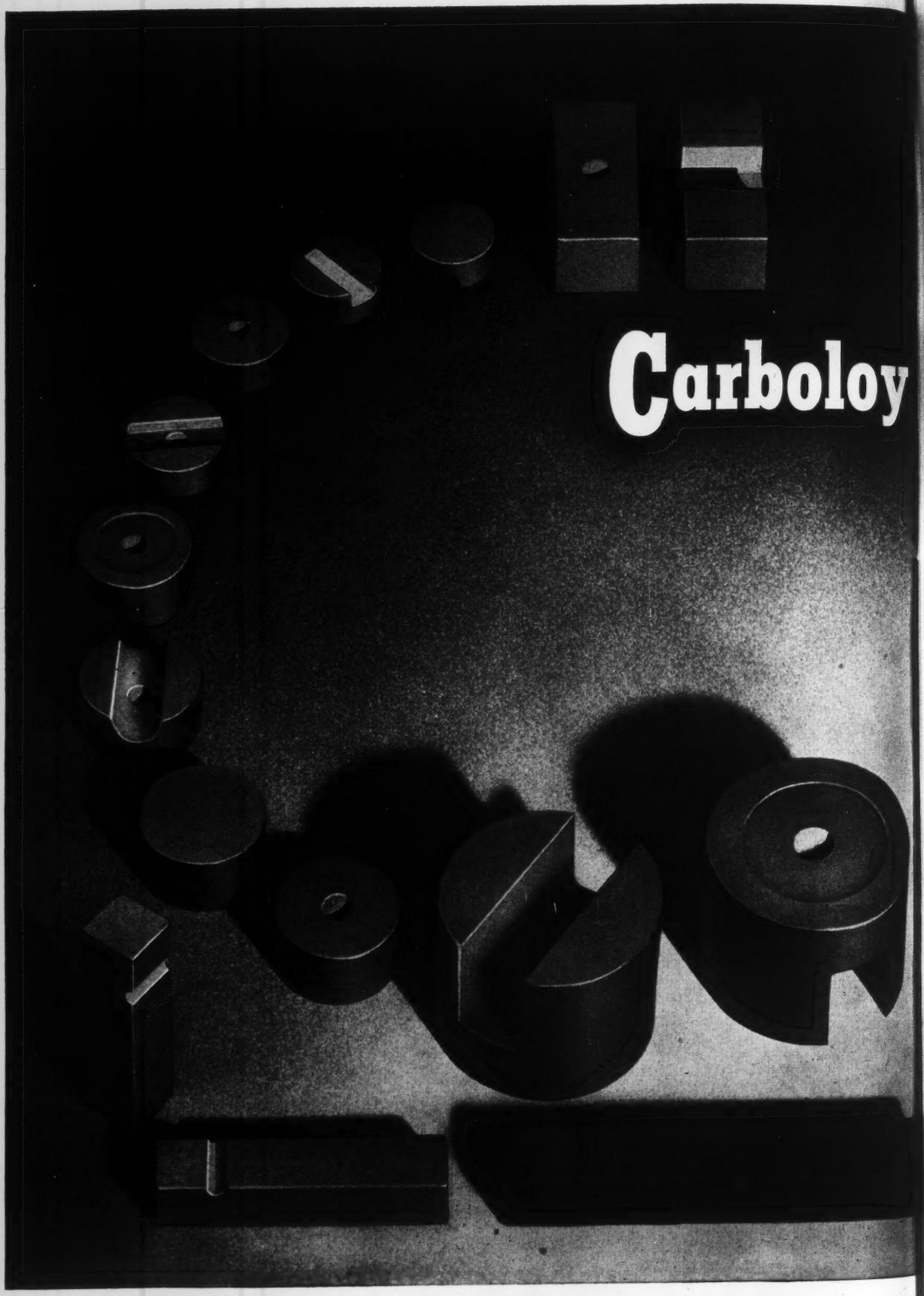
K & M valves are available in sizes from ½ to 20-inch, complete with diaphragm motor and are made in 13 different types to meet varying requirements. Constructed of semi-steel, bronze, cast steel or special alloys. Inner valves in beveled quick opening, percentage parabolic or percentage V-port design as standard. Facings range from soft rubber to stellite.

Because of their modern design, all K & M valve bodies have extremely high capacities in relation to corresponding pipe size:



KIELEY & MUELLER

Established 1879


Carboloy

Designed Right

Built Right

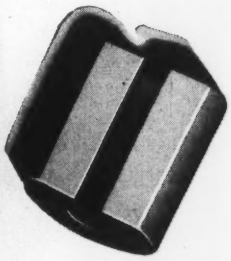
Delivered Right on Time
and with
Energy-Potential Right

y Alnico permanent magnets

Carboloy Alnico permanent magnets are job-designed to your exact needs by engineers who have years of application and research data at their fingertips from the laboratories where permanent magnets were first developed.

More, they are produced under precise and exacting quality controls that assure you external energy at a *guaranteed* minimum level consistent with today's methods of manufacture and advanced metallurgical techniques.

And, once your order is accepted, they are delivered right on time, as promised. Every one unvaryingly uniform . . . every one quality-built and guaranteed to meet or surpass the external energy minimum.



Do you need any type of permanent magnet . . . made to order, or from standard stock? For defense? To improve a generator, meter, motor or instrument? To speed up a production job with a magnetic holding or separating device? Or for a projected civilian product, perhaps?

Then get in touch with our Carboloy engineers at once. They'll give you all the assists possible on your present and future magnet applications . . . all the expert help you need to make your products better, your savings greater, your profits higher. Send specifications or write for Standard Stock Bulletin PM-100. Write direct to:

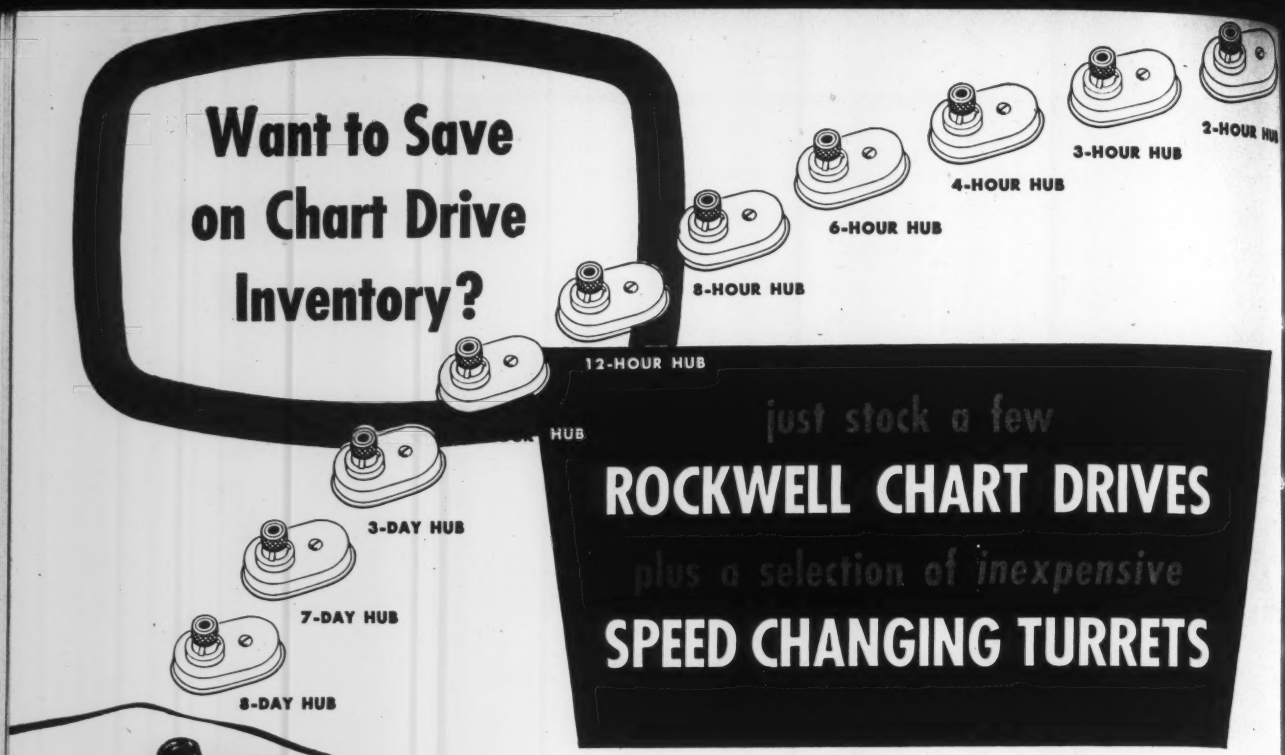
Carboloy Department of General Electric Company
11155 East 8 Mile Ave., Detroit 32, Michigan

"Carboloy" is the trade-mark for the products of Carboloy Department of General Electric Company.

CARBOLOY
ALNICO PERMANENT MAGNETS

FIRST IN MAN-MADE METALS FOR BETTER PRODUCTS

Want to Save on Chart Drive Inventory?



just stock a few

ROCKWELL CHART DRIVES

plus a selection of inexpensive

SPEED CHANGING TURRETS

Illustrating how the Turrets lock onto the chart arbor to change rotation speeds. This conversion feature is also available on the 8-day Rockwell midget drive.

For replacement service, the Rockwell standard chart drive is the most versatile, economical you can use. It is thinner than other drives and so can be correctly located in practically any instrument case by means of simple adaptors. One adaptor is furnished with each drive. Rotation speeds are no problem, either. Speed changing Turrets lock onto the chart arbor to provide any one of 11 rotation speeds. Think what this means in reduced inventory, service work, all-around flexibility of application.

Get facts now on long-lived, powerful, Rockwell chart drives. Learn how their use in your instrument shop will save time and money. Write for bulletin.

There are two basic models of the Rockwell standard drive—24 hour rotation, 8 day wind; 7 day rotation, 31 day wind. Turret speed changers provide a wide selection of alternate rotation speeds.

Write for Bulletin 1079

ROCKWELL MANUFACTURING COMPANY

PITTSBURGH 8, PA.

Atlanta · Boston · Chicago · Columbus
Houston · Kansas City · Los Angeles · New York
Pittsburgh · San Francisco · Seattle · Tulsa

You have your choice of two models in the Rockwell Midget. (1) A 24 hour drive with 24 hour rotation only, and a 48 hour rundown. (2) An 8 day drive with basic 24 hour rotation that can be converted with Turrets to 10 alternate speeds ranging from 2 hour to 8 day.

Look into this *MIGHTY MIDGET*

Compact, powerful drives for use in instruments when space is at a premium. They feature a detachable escapement, sealed in clear plastic. They wind through the chart arbor, snap into separate mounting rings which may be positioned on bosses or adaptors to fit any instrument case.

WHY ARE MORE BRISTOL RECORDING GAUGES BEING USED THAN ALL OTHERS COMBINED?

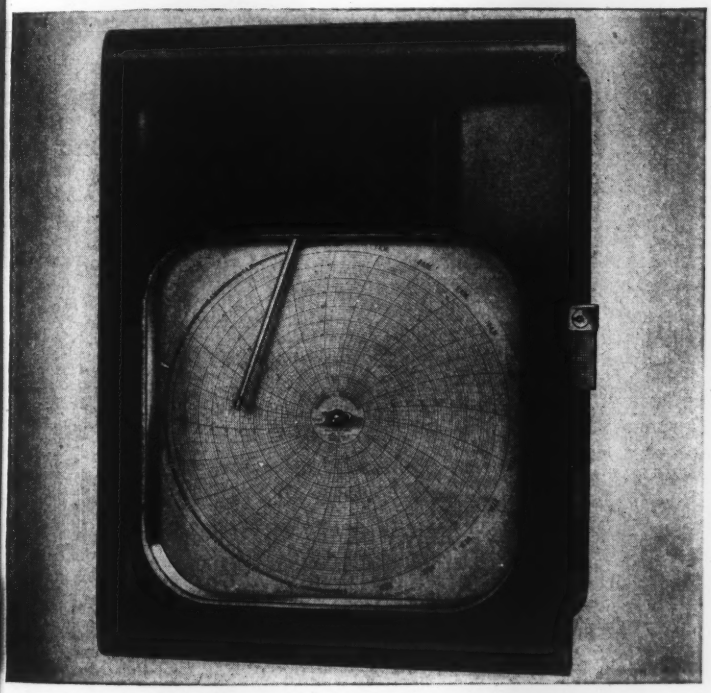
The heart of the pressure gauge is the pressure measuring element.

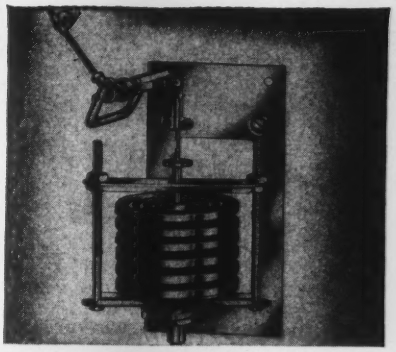
Hundreds of thousands of Bristol recording gauges in use all over the world, operating under all kinds of conditions, testify to the high accuracy, long life, and permanent calibration of Bristol's element.

Many Bristol gauges have been in constant service for 20, 30 and 40 years!

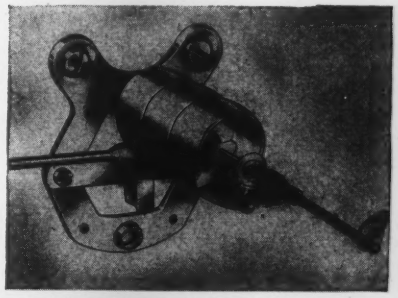
Now Bristol presents its *new* line of Series 500 recording pressure gauges in ranges from 0 to 6 millimeters mercury absolute to 0 to 10,000 psi. They have many outstanding new features which make them easier to use, convenient to service, readily convertible. And they incorporate the three most advanced designs of measuring elements.

Models are available for recording, automatic controlling, pneumatic transmission and telemetering. Immediate delivery on many ranges. Write for new 32-page Catalog G621. THE BRISTOL COMPANY, 113 Bristol Road, Waterbury 20, Conn.

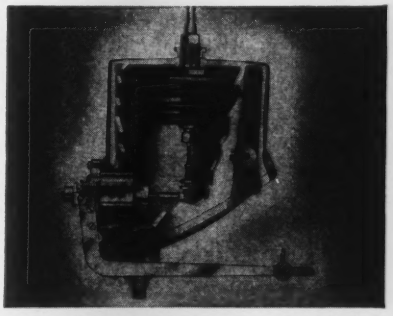




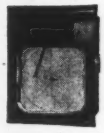
FOR LOW PRESSURE RANGES—new Type E measuring element is used for ranges from 0-2 in. water to 0-29.9 psi pressure or vacuum. Extremely high torque gives positive pen positioning across entire range. Highly accurate, extremely stable. 250% inherent over-range protection.



FOR INTERMEDIATE AND HIGH RANGES—new helical measuring element is for ranges from 0-30 psi to 0-10,000 psi. Special nonferrous alloy—heat-treated to withstand impact of rapid fluctuations—gives permanent accuracy over a long period of service life.



FOR ABSOLUTE PRESSURE—new single-bellows type element measures ranges as low as 0-6 mm. mercury absolute and gives direct reading of pressure above absolute zero inherently corrected for barometric variations—with far greater accuracy than ever before.

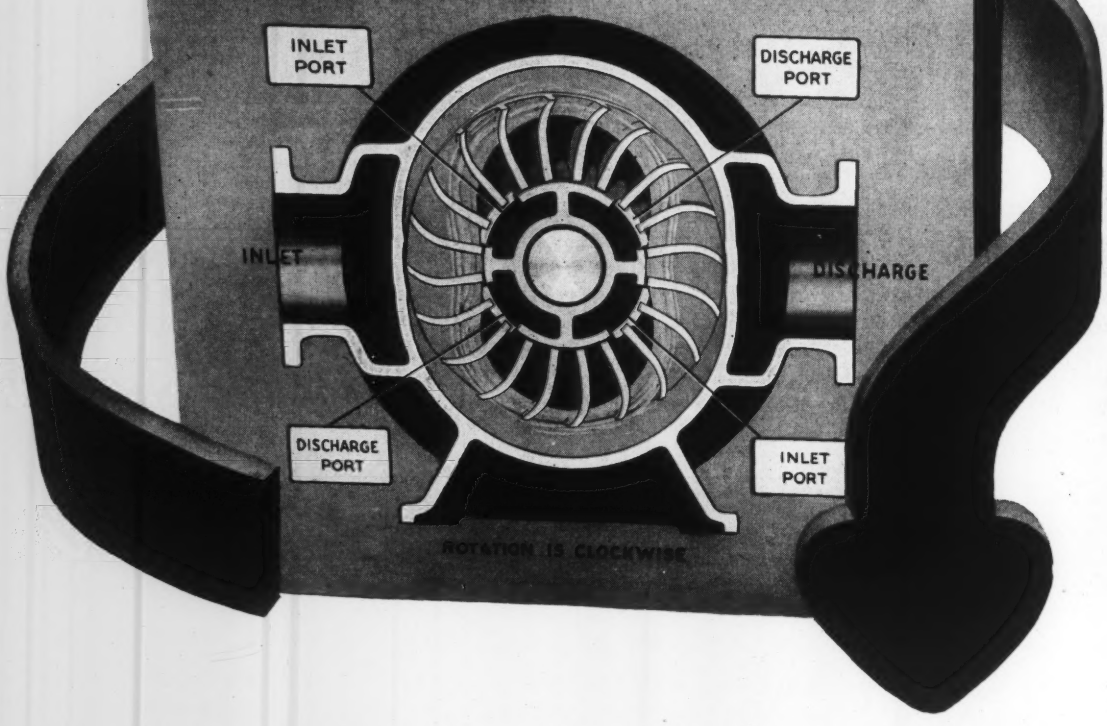


THE DEPENDABLE GUIDEPOST OF INDUSTRY

BRISTOL

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

Nash Instrument Air Compressors deliver only clean air, free from oil or dust, and without filters



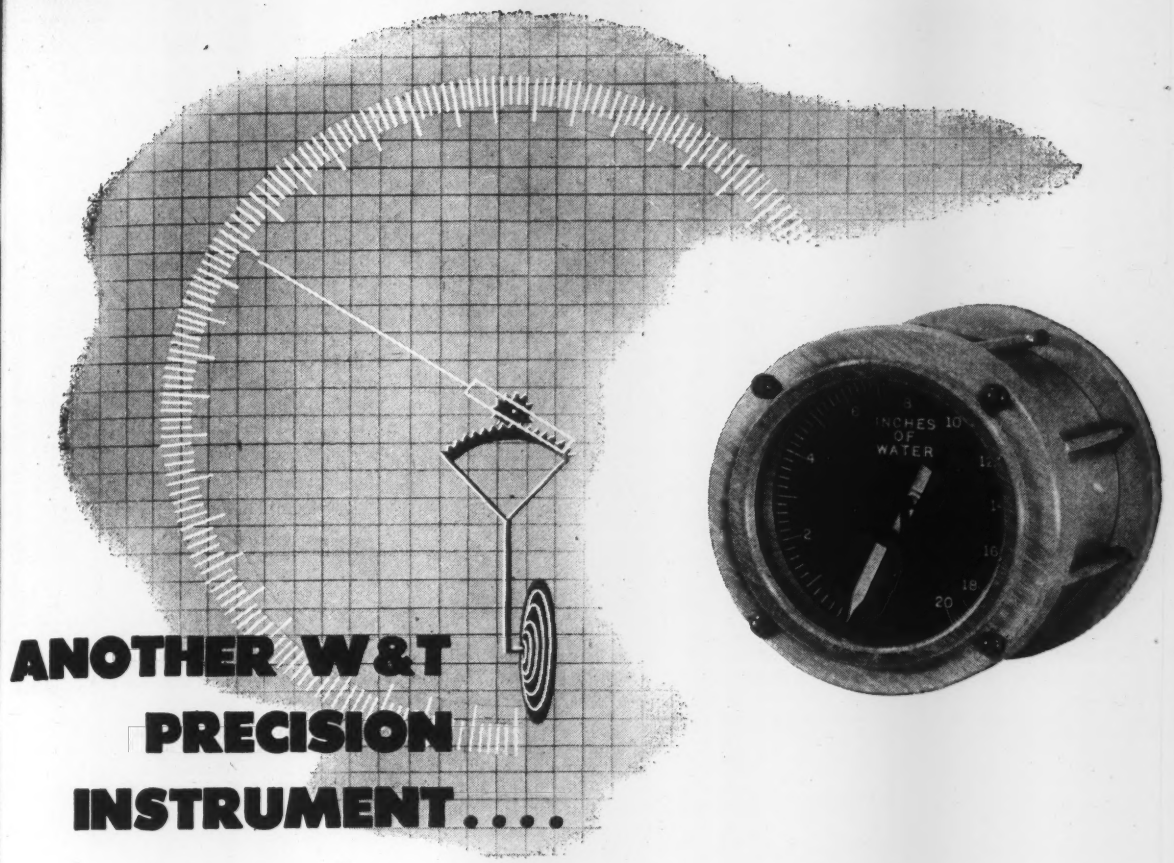
Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
370 WILSON, SO. NORWALK, CONN.



ANOTHER W&T PRECISION INSTRUMENT....

The W & T Precision Low Pressure Gauge

The W&T Precision Low Pressure Gauge has proved to be the answer to the problem of measuring low pressure accurately by successful use in such fields as aircraft flight testing, automotive research work, and engine and ventilation studies. Built with custom care from its beryllium copper capsule to its individually calibrated dial, the W&T Low Pressure Gauge is a precision instrument of the highest grade.

Here are some of its outstanding features:

- Sensitive to 1 part in 500
- Available in ranges from 0-10" of water to 0-400" of water
- Measures differential pressure
- Unaffected by gravity or acceleration
- Equipped with expanded scale if desired

Write now and tell us your low pressure measuring requirements. We'll be glad to help — no obligation, of course.

WALLACE & TIERNAN
PRODUCTS, INC.
ELECTRICAL MECHANISMS AND PRECISION INSTRUMENTS
Belleville 9, New Jersey • Represented in Principal Cities

A-78

another Case History for

DU MONT OSCILLOGRAPHY

COURTESY UNITED STATES RUBBER CO.

Success of the hydraulic IMPULSE TESTER designed by engineers of the United States Rubber Company has provided a conclusive and accurate method for evaluating the design and performance of flexible hydraulic hose.

COURTESY UNITED STATES RUBBER CO.

With its slow, driven sweeps, and d-c amplification, the Du Mont Type 250-AH CATHODE-RAY OSCILLOGRAPH is an important key to the accuracy of this "fatigue test," and to the proper operation of the impulse-test equipment.

an approved hydraulic impulse test

● Engineers of the United States Rubber Company have designed and built a prime mover whose pressure output can be tailored to conform with strict impulse-test specifications — particularly those for hydraulic hose MIL-H5511 and MIL-H5512. Through their development, it is now possible to produce *test-proved* hose for the hydraulic systems operating landing gears and control surfaces in government aircraft. And their understanding of the inherent capabilities of the cathode-ray oscillograph and its application has contributed to the completeness and accuracy of this impulse-test technique.

Thirty five times a minute, for fifty continuous hours, test lengths of the hydraulic hose are subjected to controlled dynamic pressure pulses which rise to 150% of rated pressure. Air-aged, oil-aged, and unaged hose is impulse-tested under conditions of excessive tension and unusual compression and must withstand the stresses applied under these hydraulic shocks without exhibiting fatigue.

Simultaneously, each control-impulse cycle is applied to the cathode-ray oscillograph, where both static and dynamic levels of the pressure pulse are recorded. And, because the pressure pattern can be observed in complete detail on the cathode-ray oscillograph, slightest deformation of the hose is detected as a deviation from the specified pressure-pulse pattern.

Also, faulty operation of the Impulse Tester can be detected on the cathode-ray oscillograph. And by proper interpretation of this pattern, troubles can be localized and corrected quickly.

The functions of the cathode-ray oscillograph in this hydraulic application are but typical of the diversity of fields in which it is finding more and more important uses.

DU MONT *for Oscillography*

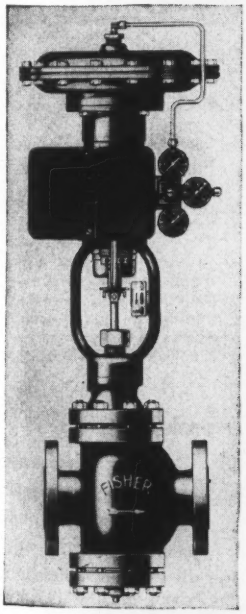
Allen B. Du Mont Laboratories, Inc., Instrument Division, 1000 Main Ave., Clifton, N.J.

For Restricted Requirements

3 STANDARD METHODS OF RESTRICTING INNER VALVES

FISHER®

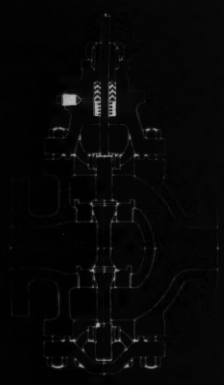
DIAPHRAGM CONTROL VALVES

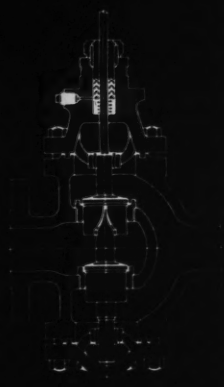


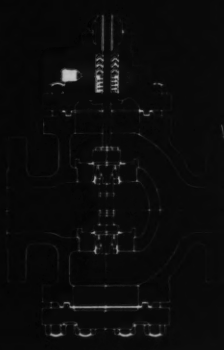
Reasons for using restricted trim: (1) where later conditions require either larger or smaller capacities, (2) a full sized valve body is desired for line strength but with low capacity requirements — Fisher 3 standard methods offer a quick, economical and completely satisfactory way of solving these problems.

Size of restriction available: Restricted Inner Valve ports should be held to minimum size of not less than 50% of standard port diameter for valve body size, or equivalent of 25% of maximum full size valve capacity.

Practical considerations have proven it is undesirable to reduce flow to less than 25% of maximum capacity of body in double ported valves.







FISHER GOVERNOR COMPANY

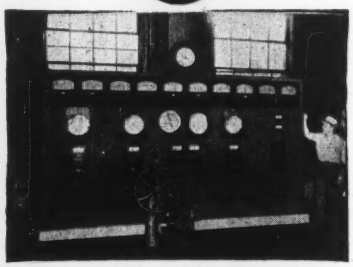
Marshalltown, Iowa

FISHER®

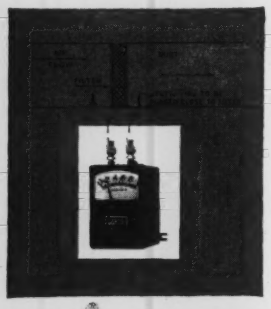
LEADS THE INDUSTRY IN R

5 ways to use HAYS

1



Pressure and Flow Measurement in Gas Producer Plant. In this automatically controlled gas producing plant Hays FOT Indicators show gas header pressure, stack pressure, air pressure, and air flow. The FOT is a popular pressure-flow instrument in the process industries.



2

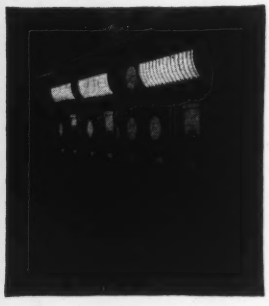
Resistance Measurement in Air Conditioning Systems. The Hays air filter gage is a money-saver when used to indicate the amount of resistance through filters in air circulating systems. When equipped with open or closed switches it flashes or sounds an alarm when resistance becomes excessive.

3

Commercial Boiler Testing Portable easily handled Hays "B" gages are widely used for checking draft in the combustion chambers of small automatically fired boilers to assure maximum efficiency. The scales are easily read—large black figures on a light background. Gages are compact, rugged.

4

Product Testing by Differential Pressure Measurement. Here the simplicity of the Hays FOT indicator makes possible testing of a complicated product by unskilled workers. Hays gages were selected because of their accuracy and because they could be supplied with large, easily read scales.



5

Continuous Draft Indication in Boiler Furnaces. Banks of Hays "V" gages are a familiar sight in thousands of boiler rooms. They provide an accurate "picture" of furnace draft conditions at any given moment and thus warn the operator of soot deposits, slag accumulations, too thin a fire, burned out baffling, etc.

HAYS has the most complete line of low pressure gages on the market.

• 4 diaphragm units available for both pressure and differential • diaphragms of colon leather or of synthetic impregnated material highly resistant to corrosive atmospheres, moisture and oxidation • 4 case sizes • as many as 12 pointers in one case • ranges from a minimum of .2″ water to a maximum of 120″ water • for indicating, recording, or controlling draft pressure, differential or flow • wall, lug, or flush mounting—also portable models • interior or exterior illumination • square root extractors available.

What's your draft or pressure problem?

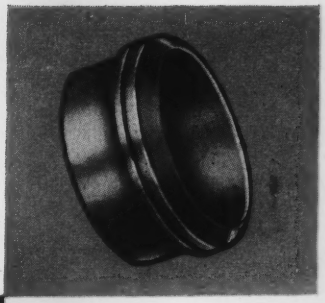
Hays engineers are anxious to help you solve your low pressure measurement and gas or air flow problems. They have applied Hays gages to situations ranging from the determination of fuel oil level in marine vessels to the measurement of the density of mud in oil drilling operations. Send a description of your problem to Clarence Miller, The Hays Corporation, Michigan City, Indiana. You'll receive Hays' recommendations plus Bulletin 49-667 describing the complete line of low pressure instruments.

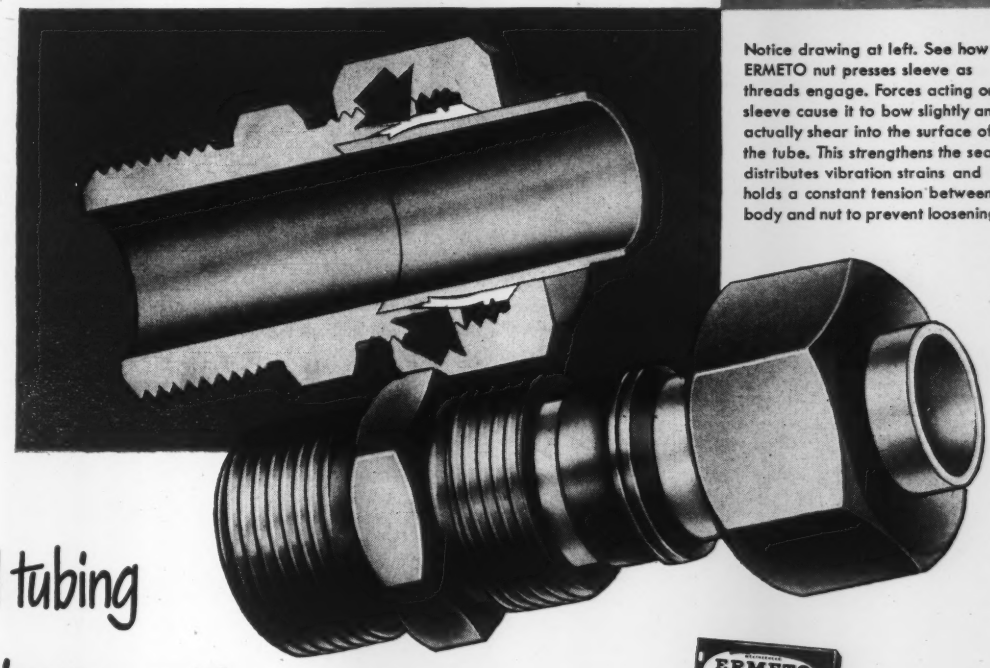
THE **HAYS** CORPORATION

MICHIGAN CITY 8, INDIANA

Automatic Combustion Control • Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol • Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders • Electronic Oxygen Recorders

This Weatherhead ERMETO® "ring" gives you timesavings up to 60%





Notice drawing at left. See how ERMETO nut presses sleeve as threads engage. Forces acting on sleeve cause it to bow slightly and actually shear into the surface of the tube. This strengthens the seal, distributes vibration strains and holds a constant tension between body and nut to prevent loosening.

on steel tubing installations... up to 40% on copper and aluminum!

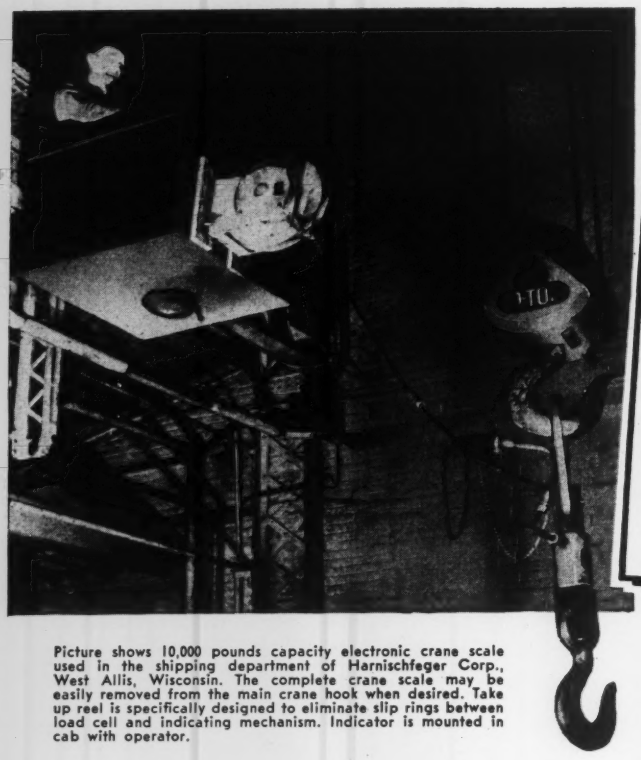
The Weatherhead ERMETO "ring" or hardened sleeve is the heart of the fitting—enables tube connections to be made at all pressures—economically at low pressures, *safely and economically* at elevated hydrostatic pressures. There's NO FLARING, NO THREADING, NO WELDING, NO SOLDERING—*fast installation with no tools but a wrench!* Easy disassembly and retightening with a pressure-tight joint. Ermeto fittings meet J. I. C. requirements.

WRITE for full information--ask for ERMETO catalog No. E-1457. Contains details on ERMETO sizes available in steel, stainless steel and brass, installation data, etc. Dept. S, The Weatherhead Co., 300 East 131st Street, Cleveland 8, Ohio.

The Mark of Quality

WEATHERHEAD

FIRST IN HYDRAULIC CONNECTIONS



Picture shows 10,000 pounds capacity electronic crane scale used in the shipping department of Harnischfeger Corp., West Allis, Wisconsin. The complete crane scale may be easily removed from the main crane hook when desired. Take up reel is specifically designed to eliminate slip rings between load cell and indicating mechanism. Indicator is mounted in cab with operator.

Announcing the

AMETRON ELECTRONIC SCALE

THE WAY TO WEIGH

Write for illustrated booklet "The Way to Weigh"

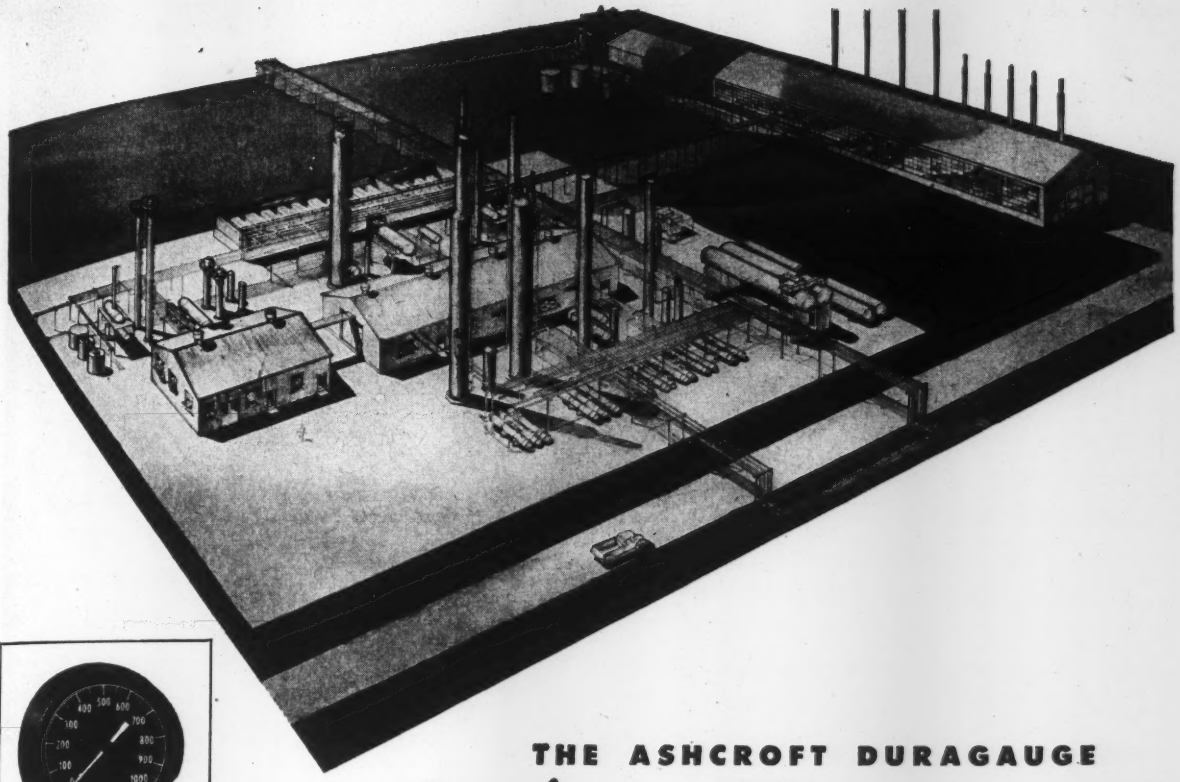
A simpler, easier, quicker way to weigh. Records while it weighs—on tape, ticket or ledger. Records by remote control in the front office what is weighed in the shipping department. A new way to keep track of production and speed up output. Easy to install any place in the factory, yards or road. Compact, light in weight, economical to operate. The result of years of study by the Baldwin-Lima-Hamilton Corporation and the Streeter-Amet Company.

THE STANDARD OF ACCURACY — THE WAY TO WEIGH — SINCE 1888

STREETER-AMET COMPANY

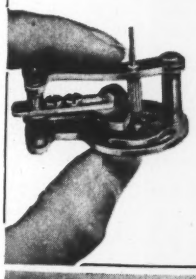
4101 RAVENSWOOD AVENUE **CHICAGO 13, ILLINOIS**

Branches in Pittsburgh, Pa. and Birmingham, Ala.



DURAGAUGE SPECIFIED!

Ashcroft Duragauges are installed in The Pure Oil Company's Crude Stabilization and Gasoline-LPG Recovery Plant at Worland, Wyoming. Contractor: C. F. Braun & Co., Alhambra, California.



THE ASHCROFT DURAGAUGE

...tough, sensitive, accurate!

The Ashcroft Duragauge has a performance record second to none. Long life in "killing" services in refineries, chemical plants, and power stations prove it.

Ashcroft engineers made the Duragauge the standard of industry by discarding traditional theories about pressure gauge construction. They developed a movement with *nylon* pinion gear and bearings.

The Nylon Movement* is light, strong and dimensionally stable. Friction and wear are minimized, corrosion resistance is increased.

Shock impact absorption is high. Maintenance is reduced. Overall advantages: greatly improved indicating sensitivity and sustained accuracy. The Duragauge, with Nylon Movement, outlasts all others.

The petroleum industry is faced with demands for increased defense and civilian production. The Duragauge can help assure uninterrupted operation. Get all the facts from your Ashcroft Distributor. Let him help you select the right Duragauge for *your* plant.

* Patented

ASHCROFT GAUGES

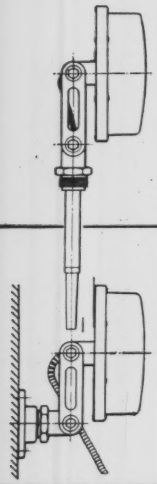
A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'ASHCROFT' GAUGES, 'HANCOCK' VALVES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS. BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

PALMER

mercury actuated Dial Thermometers

now in three types to suit any requirements

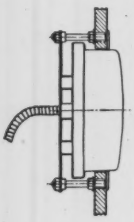


1 Rigid Stem Dial Thermometer

Rigid stem tapered bulb, interchangeable with standard industrial thermometer separable socket.

2 Wall Mounted Dial Thermometer

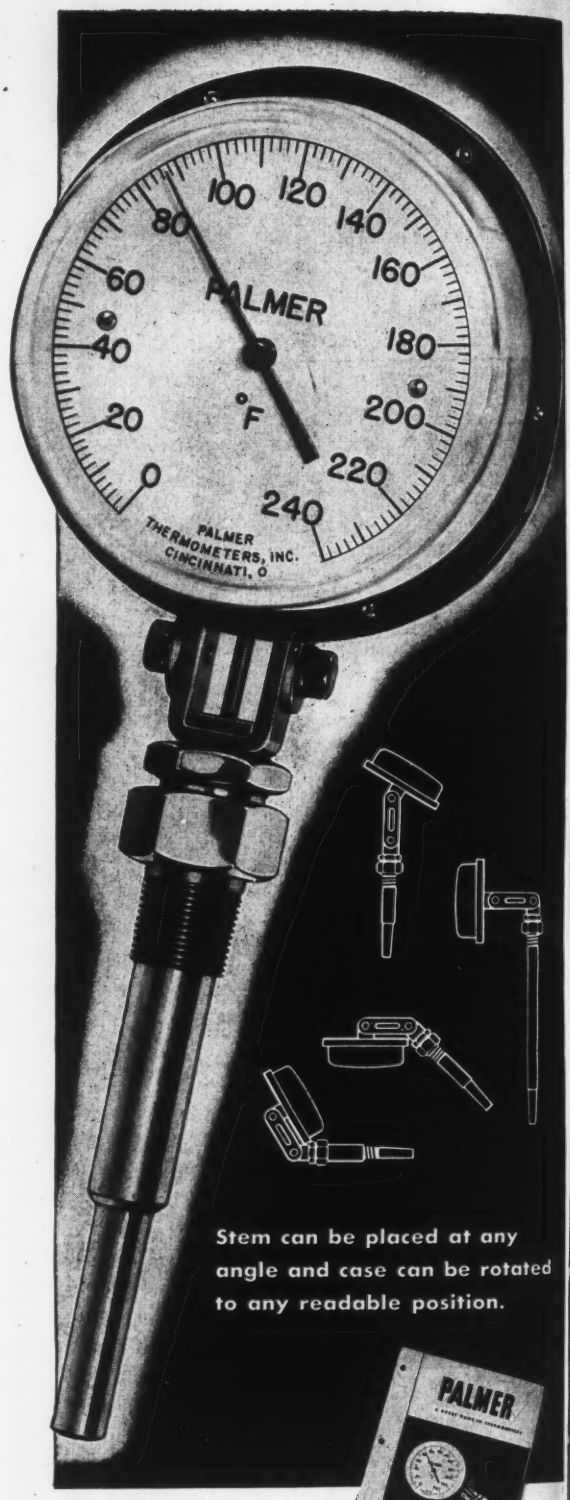
Wall mounted dial thermometer with flexible connecting armor. Case adjustable to easy reading position.



3 Flush Mounted Dial Thermometer

Flush mounted style for panel mounting with flexible connecting armor.

All three types have a full 4½" dial Face



Stem can be placed at any angle and case can be rotated to any readable position.

for accuracy: Mercury actuated . . . Fully Compensated by Invar Compensation. Guaranteed Accurate 1 scale division.

for angularity: Can be adjusted to most readable position at any angle desired.

for readability: Bold Black Numbers . . . 11" of scale Reading Dial face can always be placed in easiest readable position.

for interchangeability: Always specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.

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For details on the New Palmer Dial Thermometer, please write for Palmer Bulletin 51-129.

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Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

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ACTUAL SIZE

Model 666-HH

Volt-Ohm-Milliammeter

Mighty Midget of the Service World...

RANGES

D.C. VOLTS: 0-10-50-250-1000-5000, at 1000 Ohms/Volt.

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FOR THE MAN WHO TAKES PRIDE IN HIS WORK

Triplett

TRIPLETT ELECTRICAL INSTRUMENT CO. BLUFFTON, OHIO, U. S. A.

Slip this little V-O-M in your pocket and you become a walking laboratory for making complete D.C. and A.C. Voltage, Current, and Resistance Analyses. There's nothing "little" about this miniature marvel but its *size!* It's the mighty midget of the Service World—Truly a giant in performance.

Some of the things you get: a 3-color scale for quick-glance readability, only one switch for noticeable ease in correctly getting your range, the banana-type jacks that provide quick plug-in connections and lower jack contact resistance—and the remarkable stability on voltage ranges by use of special resistors throughout, and on current ranges with 250 M.V. instrument.

Buy Model 666-HH now—and remember, it carries the famous Triplett RED•DOT *Lifetime Guarantee.* Don't hesitate another day!

ONLY $24.50 AT YOUR DISTRIBUTOR

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excel for SAFETY wherever HAZARDOUS CONDITIONS EXIST

POWERSTAT
TYPE 1126

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THE POWERSTAT is a precision-built variable transformer operated manually or with motor drive to deliver any selected output voltage in the range from zero to or above line voltage.

EXPLOSION-PROOF means that the POWERSTAT is enclosed in a rugged cast iron housing to withstand internal gas or vapor explosions and prevent ignition of gas vapors surrounding the enclosure. Approved by Underwriters' Laboratories for Class 1, Group D service.

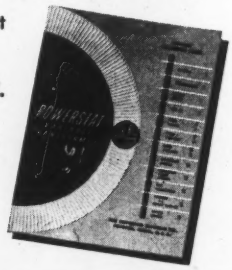
Designed for precise control of a-c power lines, Explosion-proof POWERSTATS are widely accepted and are at work in the lab, pilot and processing plants . . . providing protection in hazardous areas to men, equipment and facilities.

Explosion-proof POWERSTATS possess all the desirable characteristics found in all POWERSTATS including excellent regulation, high efficiency, conservative ratings, zero waveform distortion, smooth and dependable operation.

THIS FOLDER CAN HELP YOU SAFEGUARD PLANT INVESTMENTS

Complete with product and application information, rating charts, circuit diagrams and dimensions on variable voltage control equipment.

WRITE TODAY, SECO, 710 CHURCH ST., BRISTOL, CONN.

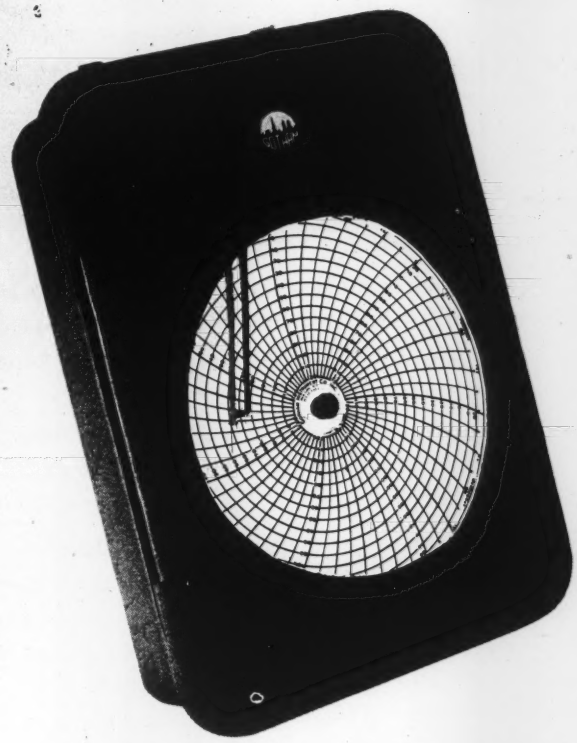


THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

POWERSTAT VARIABLE TRANSFORMERS • VOLTBOX A-C POWER SUPPLIES • STABILINE VOLTAGE REGULATORS

GOTHAM CONVERTIBLE

grows or changes to fit your needs



Want an instrument that can grow or change to fit your needs—an instrument that is a miser for maintenance and replacement inventory?—Then choose the Gotham Convertible. It is a 1-2-3-4 pen recorder; 14 pressure, temperature and time operation combinations. It is a recorder controller; there are 38 pressure, temperature and time operation combinations.

All components are Gotham standard, factory calibrated systems, completely interchangeable and easily removable or replaceable at the job site.

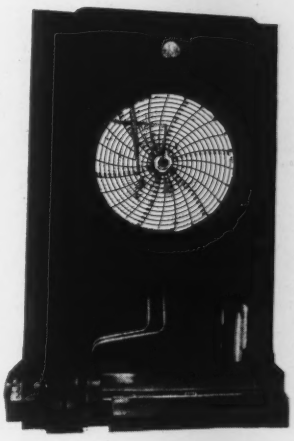
Number of functions possible depends on whether instrument is 6", 9" or 12" chart size.

GOTHAM INSTRUMENTS

Keep everything under control with Gotham

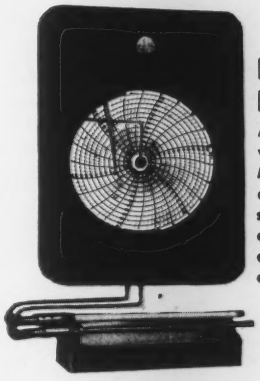
SELF-CONTAINED PORTABLE RECORDER

Here, at last, is a portable recorder built to full-size instrument reliability. Built from Gotham standard elements, interchangeable with other Gotham instruments. 6", 9" and 12" chart sizes. Mercury, Vapor or Pressure Actuated. Spring or electric chart drive. See Catalog 400.



RECORDING PSYCHROMETER

Incorporates highly accurate and responsive thermal systems and many other Gotham standard convertible elements. Wet and dry bulb type. Motor-driven suction fan. 12" chart size. Catalog 400.



RECORDING HYGROMETER

A 2-pen recorder of the wet and dry bulb type. Mercury or Vapor Actuated. 9" and 12" chart sizes. Available with variety of wet and dry bulb assemblies depending on application. Catalog 400.

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Division of American Machine and Metals, Inc.
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- ☐ Catalog 100—Industrial Thermometers
- ☐ Catalog 200—Dial Type Thermometers
- ☐ Catalog 400—Recorders, Psychrometers, Hygrometers
- ☐ Catalog 500—Controllers
- ☐ Have your representative call. No obligation.

Name.....Title.....

Company.....

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City.....Zone.....State.....

More jobs for Instruments Means Better jobs for Men

AMERICAN industrial workers have the shortest hours and highest real wages in the world.

THEY have attained this position because production per man is higher than in any other country—and this in turn is due primarily to industry's constant development of more efficient methods and equipment. This development proceeds on many fronts, but today major progress is being made through *instrumentation.*

INSTRUMENTATION in industry has two functions: (1) to provide precise measurement of factors involved in industrial operations, and (2) wherever possible, to utilize these measurements for the automatic *control* of processes. Certain types of work, in the field of nuclear energy, for example, are possible only through instrumentation, but in any field adequate instrumentation means greater production per man-hour.

THE AMERICAN WORKER does not resent this. He has learned that, although a well-instrumentized plant requires fewer men per unit of production, employment in such a plant is more stable and the available jobs less onerous and more remunerative. He knows that more jobs for instruments means more and better jobs for men.

THE FIELD for instrumentation is wide open. No industry, and few individual plants, have taken full advantage of its possibilities. Yet in instrumentation lies the opportunity to obtain the increased production which our expanding economy demands, and to obtain it without opposition from the workers involved.

This advertisement published as a public service by the INSTRUMENTS PUBLISHING COMPANY, PITTSBURGH 12, PENNA.
A sample copy of INSTRUMENTS—*The Magazine of Measurement and Control, will be sent on request.*

This advertisement was prepared by KETCHUM, MACLEOD & GROVE, INC., Pittsburgh, Penna. *Advertising Agency for* BALDWIN-LIMA-HAMILTON CORP., HAGAN CORP. and MINE SAFETY APPLIANCES COMPANY

versatile!

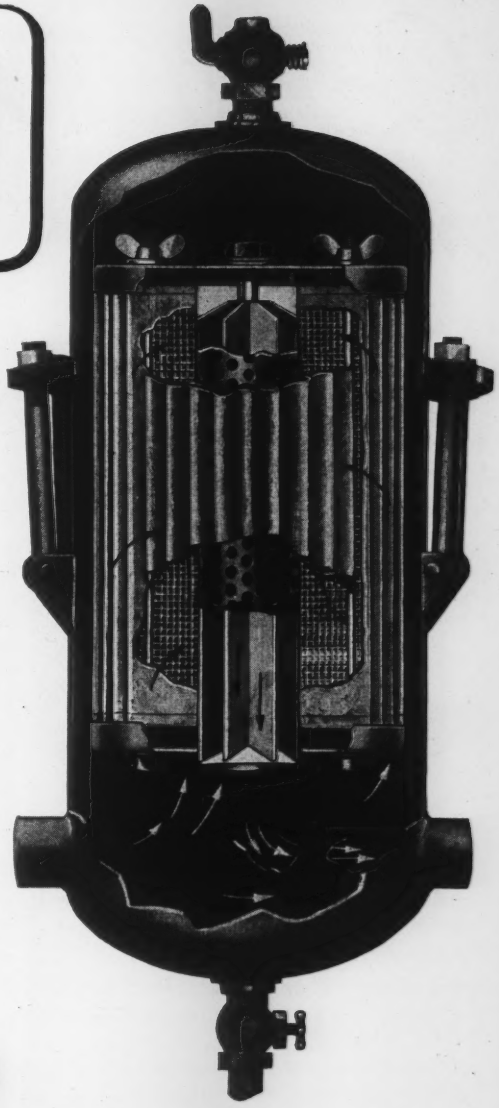
handles:

CAPACITIES TO 3000 GPM*
TEMPERATURES TO 1000°F
ANY DEGREE OF pH
PRESSURES TO 6000 LBS.

A recent survey showed hundreds of liquids in a wide range of viscosities, temperatures, acidities, alkalinities, pressures and capacities successfully handled by Staynew Filters. Since the exclusive Staynew design permits use of *any medium in sheet form that can be crimped*—metal, plastic, fabric, ceramic and mineral media could be used for filtration in degrees of fineness to 2 microns. Parts exposed to the action of the liquid were built in Stainless Steel, Monel, aluminum and Inconel as well as in steel, iron and bronze—yet the basic and efficient Staynew design remained the same in every case.

This survey not only demonstrated the unsurpassed versatility of Staynew Filters, but added to the already large store of specialized data compiled by Staynew engineers . . . data available to anyone with a problem in filtration.

*Unlimited in Multiple Units



Staynew Radial Fin Construction provides the largest possible filtering area for available space. **Slip-On Insert**—exclusive in Staynew Filters—permits simple, inexpensive replacement of media.

Staynew LIQUID FILTER

PARTIAL LIST OF LIQUIDS FOR WHICH STAYNEW FILTERS ARE IDEALLY SUITED

Water	Plastic Solutions	Miscellaneous Chemical
Acids	Petroleum Products	and Aqueous Solutions
Paints	Liquefied Gases	•
Varnishes	Organic Liquids	*BULLETIN D-1L ON REQUEST.*

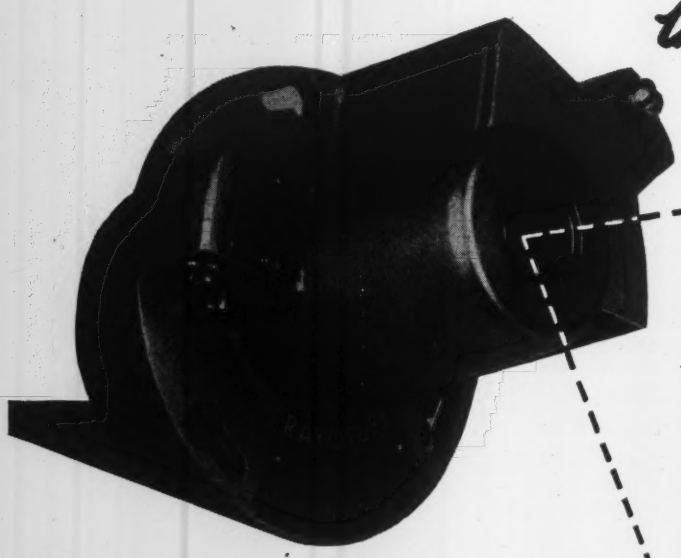
REPRESENTATIVES IN PRINCIPAL CITIES

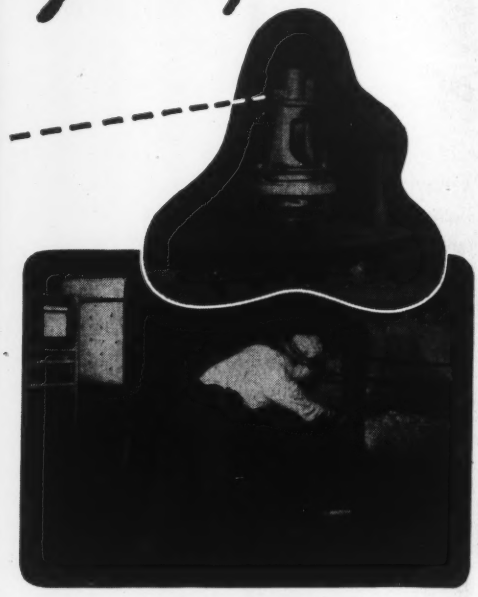
DOLLINGER CORPORATION

63 CENTRE PK., ROCHESTER 3, N. Y.

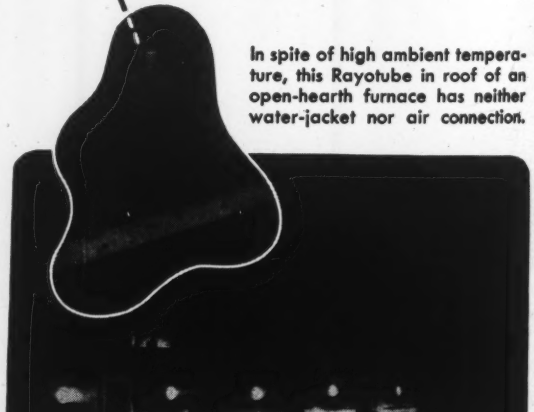
DOLLINGER PROTECTOMOTOR STAYNEW FILTERS

Can this new Rayotube mean better control of temperature in your plant?





In Henry Disston & Sons, Inc. plant, Rayotube in slab furnace roof needs no water-jacket against high ambient heat.



In spite of high ambient temperature, this Rayotube in roof of an open-hearth furnace has neither water-jacket nor air connection.

BUILT to detect temperatures for either Speedomax or Micromax Controllers, this new Rayotube No. 8890 has three features which help to improve the accuracy of control action.

1. The water jacket often needed for earlier Rayotubes is seldom required for this one because accuracy is not affected by ambient temperatures unless the head housing itself (shown above) exceeds 350 F. Omitting the jacket greatly simplifies installation and saves both water and maintenance due to water lines.

2. Overheating the Rayotube head to as high as 500 F does no harm; the accuracy decreases above 350, but returns fully as temperature drops. Thus, a few minutes' glare from an open furnace door does not affect the instrument's usefulness.

3. New, quick-sighting optical system for aiming the Rayotube at area of important temperature is especially helpful when aiming down an open-end tube to measure directly the surface temperature of parts being heated.

Catalog N-33B describes all Rayotubes as well as Speedomax and Micromax Pyrometers; we also can send description of this Rayotube only. Kindly address either our nearest office, or 4955 Stenton Avenue, Philadelphia 44, Pa.

Jrl Ad NS3(2)

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

"One *of the* Great Technical Events *of the* World"

WITH these words, J. B. McMahon, President of the Instrument Society of America, opened the Speaker and Press Breakfast Meeting of the 1951 Conference and Exhibit of the Instrument Society of America in Houston, Texas. His words were a simple statement of fact. Over 6,000 production executives, manufacturers, engineers and technicians availed themselves of this unique opportunity to see a large percentage of the American instrument industry. Visitors from other nations included engineers from Finland, Germany, France, Holland, and Mexico.

An important source of America's phenomenal strength and power was proudly revealed. Devices for pushing production to ever-increasing heights were evident on all sides. The ingenuity and mechanical skill by which the most advanced physical phenomena are put to work as the eyes, ears, and brains of industry cannot be described. But those who were fortunate enough to see it received an education and perspective on America's power.

It is impossible to report on all the new instruments shown for the first time at the Instrument Show. However, all the new instruments exhibited have been or will be reported to our readers in the New Instruments Department of *Instruments* magazine.

Miniaturization

A significant trend to miniaturization was apparent. Many of the largest instrument companies featured new designs which reduce the required panelboard area per instrument. The reasons are obvious. When large plants had few instruments, there was room on one panelboard for any size instrument. But now that plants use instrumentation to measure, record, and control each phase of production, panelboard space is precious. Hence the trend to miniaturization and small panelboard area per instrument.

Electronics

Another significant trend is the extensive use of electronic circuitry. Amplifiers, oscillators, signal converters, etc., could be seen inside the cases of dozens of basically pneumatic and hydraulic instruments. Many new systems featured "all-electronic" operation. It is obvious that all instrument men now need another technique—electronic circuitry. Our readers are reminded again that *Instruments* is featuring an educational serial on Instrument Electronics. The large number of displays of electronic test instruments proved that the electronics industry is aware of the growing importance of electronics in industrial instrumentation.

Scene at the Instrument Show. Left-to-right: Dr. A. O. Beckman, President-elect of the ISA; Porter Hart, Head of Instruments, Dow Chemical Co. of Freeport; Dr. H. P. Beutel, General Manager, Texas Division, Dow Chemical Co., Richard Rimbach, Executive Secretary and Exhibit Manager for ISA.

Recognition

Still another significant trend—and one for which *Instruments* has fought for years—is the growing recognition of instrument men by industry executives. Industry sent both its executives and its instrument men to Houston. Some industries flew their men to Houston in special planes.

Analysis

Another significant trend was the extensive display of analysis instruments. Infrared analysis, gas analysis, mass spectrometers, and others are the instruments by which processes *soon* will be controlled completely. Continuous quality analysis already has been applied to many industrial processes. The technique and the instrumentation was shown to industry by the manufacturers of the analysis equipment.

Tabulating and Computing

A field of instrumentation which will be used in conjunction with instruments for measuring production and quality is automatic data recording, tabulating, and analysis. Several instruments were shown which receive data from measuring instruments and prepare this data into a form suitable for computing machines.

An article in a Houston paper "predicted" that instruments will measure process quality, compute necessary corrections, and make automatic corrections. The prediction was made obsolete on opening day. Instruments to do every predicted task were on display. Some instruments were designed to receive data and punch tape or cards suitable for computers.

New Designs

Familiar and conventional instruments showed many improvements in design and appearance. For example, valve improvements included redesigned valve bodies, new diaphragm materials for valves, and new finishes. One manufacturer ordered a finish of special attractiveness for the valves he put on display. He was surprised to find that his finish for the show-designed valves was not only more attractive and more utilitarian, but also cheaper than his existing finish. From now on, his customers will receive "show-designed" valves.

A large number of instruments for research were on display, including the latest recording oscillographs in single- and multiple-channel types.

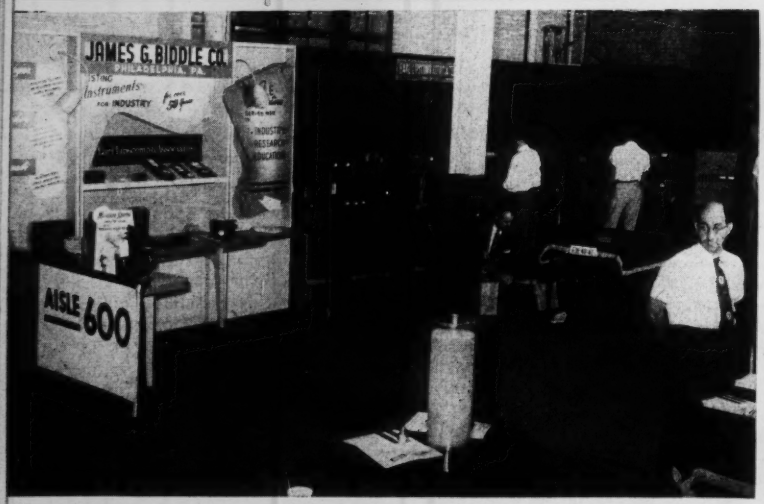
People

The show was a success in another important respect. The men of industry who are now designing new processes, new plants, and new factories came and met the men who can supply them with the instruments needed to produce and maintain high quality and high production. Aside from the dollars-and-cents implications of this important fact to the exhibitors, the total production ability of the entire country was enhanced. All who came to the show—instrument manufacturer, instrument maintenance man, process-control engineers, design engineers, and industrial executives—felt enriched by the experience.

—MHA

INSTRUMENT-COMPANY EXHIBITS AT HOUSTON, SEPTEMBER 10-14

On these eight pages Instruments takes pleasure in reproducing ALL the photographs of commercial exhibits (78 in number) received up to closing-date for this October issue.



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THE WORLD OVER

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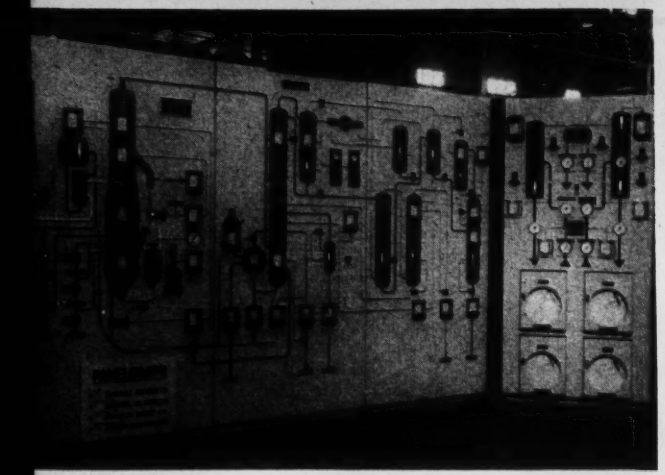

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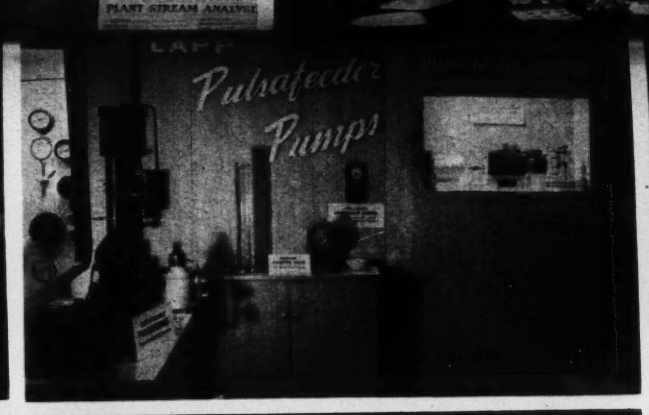
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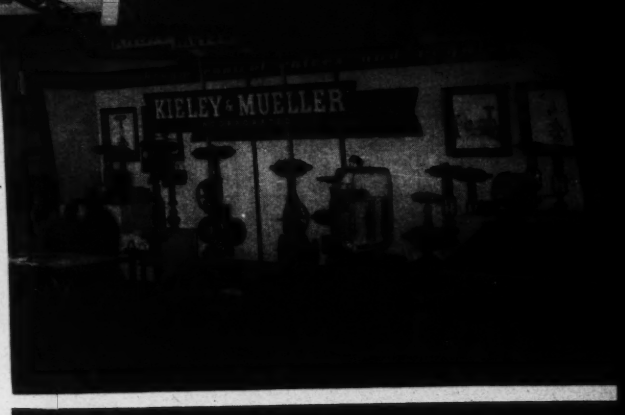
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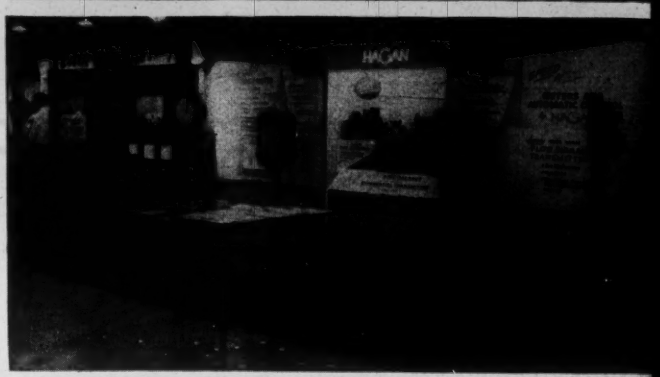
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INSTRUMENTATION in the Petroleum Refining Industry*

Instrumentation has passed through the Recorder and Controller Eras to reach the Analyzer Era. Product quality analyzers will control many continuous processes; accounting machines will be tied into the plant instrumentation system.

By JAMES HARROP†

INSTRUMENTS are to the oil refiner what eyes and ears are to the human being. All of the senses might be included because instruments do everything but the mental processes, and they are closely approaching in that respect.

A review of what has happened in the refining industry since the turn of the century provides an understanding of the tremendous progress that has been made during this period. Instrumentation has kept pace with that development during this era.

The most important factor that has influenced this great industrial advancement is the "production-line" technique—that is, continuous-flow operations. Originally, most processes were batch-wise—the batch "still" was used to boil off kerosene for lamps and to make small amounts of lubricants and waxes. The gasoline and heavy bottoms were by-products and created a problem in their disposal.

Instruments available in those early days were those already in use in steam power plants—pressure gages, thermometers, sight gage glasses and a few measuring devices. These last were unreliable and flow was computed by counting pump strokes, by gaging tanks, and even by valve spokes. All measurements, except pressure, had to be read at the point of measurement, which involved inconvenience, discomfort, hazard to personnel, and questionable accuracy.

Era of Recording

Then, in the early twenties, continuous process operations were developed, including the high-temperature, high-pressure cracking processes. Temperature and pressure measurements became critical points of control of operations and safety. Measurements of rate of flow were also necessary. Thus, process instrumentation entered into the "Recorder" era. Recordings aided the operators in observing changing conditions with respect to time and guided them in making manual adjustments to obtain uniform operating conditions. Supervisor personnel was able to function more effectively on a round-the-clock basis.

About this same time of development of continuous and recorded operations, the instrument man appeared. He was usually a gadgeteering Machinist or Electrician. The Baytown Instrument Department was organized in 1925 with five men from the Machine Shop and a "Pyrometer Man."

In the late twenties, experiments were started with "controllers." They were "controllers" in name only and could hardly be classed as "regulators." Most of these instruments were merely "off" and "on"; they could not handle even minor variations if desensitized to give smooth operations under ideal conditions.

Era of Control

It was not until the mid-thirties that outstanding advances in petroleum technology were made. And the development of industrial instruments maintained almost the same pace. At this time, the first fully automatic controllers were developed. "Automatic Reset" made it possible to supplant manual control; in fact, the human operator was taken off the valve, and replaced by the pneumatic instrument and actuator.

The era of automatic control was started and with it new and complicated processes were developed. Many of the process units now in use would be both physically and economically inoperable without automatic controls.

For example, a hydroforming unit with four fixed catalyst beds, alternately on reaction and regeneration, requires operation of 35 motor-operated valves in exact sequence and under close tolerances of operating conditions. A reactor cycle, usually of four hours' duration, requires operation of each valve at least twice during the period. It would be almost impossible to staff this unit with enough men to open, close, and regulate these valves at the exact times required.

Then again, the huge fluid catalytic cracking units, circulating catalyst at a rate of 40 tons per minute, and with vessels set in a structure 20 stories high, could not be operated manually. Automatic instruments permit instant response at the operator's touch and operate 36-inch valves hundreds of feet away as easily as they can a ¼-inch valve inside the instrument case.

Instrumentation has not only made possible the large and complicated Process Units but also has permitted the combination of several processes into one unit with its attendant reduction in construction and operating costs.

The petroleum refinery is a source of raw materials for chemical industries. Whether these raw materials are existant in the crude oil or are synthesized in the refinery operations, the product quality and purity of these materials is quite important and stresses the need for sensitive instrumentation. For instance, product streams of higher than 99 percent purity of a single component are not unusual. Control of one fractionating tower operation is so important that variations of ¼ degree F. on a specific plate can result in product quality losses of $800 per day.

Other advantages should not be overlooked. For example, safety is of prime importance. With dependable instruments, operations can be carried out at near maximum rates, pressures, and temperatures without endangering personnel and equipment.

Instrumentation—particularly measurement of gases and liquids—is an aid to the accountant and permits the preparation of realistic cost analyses. Distribution of utilities, such as power, steam, water, and air, are charged against operations from meter readings.

Manpower

The effect of instrumentation on process manpower costs can be appreciated when one realizes that the average process industry job costs between $15,000 to $20,000 per year to man around-the-clock. One operator can

*Talk presented before the luncheon of the Scientific Apparatus Makers' Association, Rice Hotel, Houston, Texas, September 12th.

†General Superintendent, Baytown Plants, Humble Oil and Refining Company.

James Harrop, General Superintendent of the Baytown Refineries of Humble Oil and Refining Co., addresses the luncheon meeting of the Scientific Apparatus Makers' Association at the recent ISA National Conference and Exhibit. The meeting was held in the Rice Hotel, Houston, Texas on September 12, 1951.

Seated left to right at the head table are: W. A. Wildhack, First V.P., ISA (National Bureau of Standards); Walter Goehring, Chief, Process Control Instrument Branch, Scientific and Technical Equip. Div., National Production Authority; Dr. A. O. Beckman, President-Elect, ISA (President, Beckman Instruments, Inc.); W. H. Curtin (President, W. H. Curtin Co.); Mr. Harrop (standing); J. Claire Evans, President, SAMA (President, Denver Fire Clay Co.); J. B. McMahon, President, ISA (Vice President, Republic Flow Meters Co.); R. G. McCurdy, Deputy Director, Scientific and Technical Equip. Div., National Production Authority; Richard Rimbach, Executive Secretary, ISA (Publisher, *Instruments* and *The Instrument Maker*).

handle from three to twelve controls in manual operations, depending on such factors as size of valves, distance separating the valves, and the speed of response from changes or adjustments. For example, one man could maintain temperatures on as many as 12 shell stills in a battery; whereas, on cracking furnaces with more severe firing rates and short time lag, the same man would have more difficulty maintaining temperatures on two furnaces. Automatic control can do practically every process job more efficiently and economically than can manual control.

Along with all these developments in refining processes and the associated instruments, let us see what happened to the Baytown Instrument Department that was organized in 1925 with its six-man crew—bearing in mind that its function was primarily installation and maintenance. By 1935 this group increased to 35 men, and in 1945 reached a peak of 170 men at the end of World War II. These increases were generally in step with refinery operations based on crude runs—which increased from 40,000 barrels per day to 100,000 barrels per day and then to 185,000 barrels per day for these corresponding periods. However, crude runs are not necessarily a direct measure of process operations in a large refinery where specialties such as lubricating oils, solvents, aviation gasolines, and synthetic rubber are produced along with fuel products.

Today the Instrument Department is functioning with 125 men even though crude runs are up to 250,000 barrels per day. This is possible due to technological improvements in design and construction of instruments. Preventive maintenance, better process-unit design, and employee know-how permit the maintenance of a greater number of instruments than before.

Analyzer Era

What are the future trends in the use of instruments? It is my belief that the "analyzer age" in continuous process instrumentation has started.

Until now, I have been talking primarily about "environment-type" instruments—those which control temperature, pressure, liquid level, etc. It is general practice to instrument a process to hold these conditions constant at values which permit production of a certain product at a given rate. It is customary to take periodic samples of the product stream for analysis by the control laboratory. Results of such analyses are transmitted back to the unit operators who make process condition modifications if any are required. Such control testing requires the presence of round-the-clock laboratory personnel. It also requires time —often several hours for return of test results. Economic studies have shown that "moving the laboratory to the unit" can sometimes be justified on the basis of either savings in laboratory test costs, or the reduction of product loss caused by delays in obtaining sample test results at the unit. This is particularly true if it is possible to make the control tests at the unit with a continuous analyzer-type instrument.

Great strides in the development of continuous analyzers were first taken during or shortly after World War II. The spectroscopic techniques of the research laboratory now are developed to the point where it is not uncommon for a petroleum refinery to have several plant-type infrared gas-analyzing instruments. Ultraviolet spectrometers for plant use are available, as are instruments operating on magnetic-susceptibility, thermal-conductivity, and dielectric-constant principles.

An infrared analyzer has been applied to the determination of the carbon-monoxide content of flue gas at one of the fluid catalytic cracking units. An analyzer operating on the magnetic-susceptibility principle is measuring the oxygen content of regenerator flue gases at both catalytic crackers, and others are in a similar service at the Hydroforming Unit. At the Hydroforming Unit these instruments guide the regeneration of beds of catalyst worth over a half million dollars, and it is hoped that they may make it possible to increase the life of the catalyst by several fold. At the catalytic crackers, the information from such analyzers helps the operators minimize after-burning with its damage to catalyst and equipment. Instruments functioning on the capacity or dielectric-constant principle are being used in the measurement of the aromatic content of certain refinery streams.

Product Quality Control

It has been said many times before that if it is possible to measure accurately, it is possible to apply automatic control. It is inevitable that at least some of these continuous analyzing instruments will, in the near future, control the product quality directly.

The evolution of plant-type analyzing instruments from their research laboratory counterparts has not been completed. Most of the plant spectrometers now marketed are adaptations of laboratory designs. They are bulky, fragile, and complicated. They involve too much glassware, rubber tubing, etc. Electrically-heated, thermostatically-controlled cabinets are all too common. Analyzers are difficult to explosion-proof for hazardous areas—and the analyzer section *must* be located in the plant because modern safe practice forbids bringing hydrocarbon samples into the control room. Future de-

velopments should be pointed toward simplification of these instruments.

The oil-refining industry needs these new instruments designed specifically for plant use. This can be brought about by close cooperation between our engineers, research groups, instrument technicians and the instrument manufacturers. Our refinery has two research employees assigned to the development of continuous analyzer techniques and their application to plant use. The refinery Engineering Division includes a group of four engineers whose primary concern is the application of all types of instruments and the design of instrumentation systems. These people maintain contacts with others in the process industries through their respective technical organizations —the Instrument Society of America and the American Petroleum Institute. It is through the efforts of these groups and of the instrument manufacturers' engineers that the future development of instruments to meet our needs must come.

Plant Accounting

I have already said that the product-quality analyzers will some day function to control nearly all continuous processes. Development in instrumentation will not cease there. It is certainly conceivable that, at some time in the future, yield information will be transmitted from the plant control room direct to the accounting machines. It is known that at least one instrument manufacturer is working now with IBM on phases of this development. It involves, I believe, the use of strip charts of IBM punch-card width for scanning and integration by the IBM machine. The analysis of pilot unit and process plant data from instruments by IBM-type machines is already being studied by research groups.

Summary

To get back to the present—the indications are that instrumentation will continue to be a major factor in the battle to produce higher-purity products. Instrumentation will continue to help reduce operating manpower requirements to the "irreducible minimum." Finally, instrumentation will continue to contribute heavily to the reduction of refining costs in an industry whose product prices have persisted in their downward trend since its inception.

Measuring Instruments and Controllers at the German Hanover Fair

Reported by Dr.-Ing. HEINRICH TOELLER*

Construction and design factors of German instruments for measurement, recording, and controlling can be of practical interest to the American instrument industry. Present practice and trends in design and application are discussed.

DESIGN of an instrument is influenced by many factors, including the industry which wants the instrument, the magnitude of the market, the supply of material, and the development capacity of the industry. Therefore it is not surprising that the American engineer sees some instruments in Germany which he seldom sees in the USA, and vice versa.

This article reports not only on instruments which were shown for the first time at the fair in Hanover, but also on the measuring instruments and controllers which have found wide application in Germany.

Construction and Design

Shielding. For several decades, moving-coil instruments and electrodynamometers have been manufactured with the high accuracy of 0.1 percent. However, the development of these instruments is not yet at an end. The high accuracy of these instruments is useful only if it is maintained in the presence of foreign magnetic fields, which exist in every electrical laboratory. As the foreign fields are not homogeneous, the astatic arrangement has only a limited effect. It is becoming customary to shield electrical measuring elements magnetically. Modern soft-iron alloys with a coercive force of only a few hundredths of an oersted make good shielding possible even at high magnetic-field intensities.

Light-beam indicators. A second construction principle consists in employing light-beam indicators in precision instruments. A light beam can increase sensitivity and speed of adjustment. By using light beams reflected from mirrors mounted on the measuring element, it is possible to magnify the scale two or three times, and thus increase the reading accuracy. Whereas formerly only moving-coil instruments and electrodynamometers had high accuracy, now soft-iron instruments can be precision instruments. By employing high-permeability alloys and suitably shaped iron cores, it is possible to reduce the direct-current error to less than 0.1 percent. Therefore the soft-iron instrument now can be used as an alternating-current precision instrument and can be calibrated with a direct-current compensator.

Ribbon suspension. All users of measuring instruments know that the supports of the moving system are critical. Especially in portable precision measuring instruments, a slight impact injury to the sensitive pivot changes the accuracy of the instrument considerably. A German instrument company has developed a thin ribbon suspension which eliminates friction from the measuring element. Although a conventional thin metal-strip suspension can be easily destroyed by an impact or blow, a special spring makes it possible to build a ribbon suspension relatively insensitive to impact.

The tension ribbon support is used not only for portable instruments with vertical shaft, but also for switchboard instruments with horizontal shaft. The advantages are (1) the instrument is less sensitive to impact and (2) manufacture is cheaper because no jewel bearings, pivots, and bronze springs are required; the entire support is a simple ribbon.

Shape. In the field of switchboard instruments it is worth noting that round-faced instruments are being replaced more and more by square-faced instruments. The Germans favor a design in which the pivot of the pointer is in the lower right corner so that in the zero position the pointer is horizontal. In a large switchboard installation it can then readily be seen that the plant is stopped because all pointers are in a horizontal position.

Standardization. For ease of interchanging instruments of all makes, all German instrument companies have standardized sizes of their switchboard instruments, both for the round- and square-faced instruments and also for the rectangular-faced instruments. The instruments are graded in size so that a harmonious assembly of different square-faced and rectangular-faced instruments is possible.

Measuring Instruments

Most portable, electrical measuring instruments which measure several variables (multiple measuring instru-

* Hartmann & Braun A-G.

ments) have been used for measuring voltage, current, ohmic resistance, and capacity. At the fair in Hanover, multiple measuring instruments were shown which permit measurement of phase angle (cos θ) also, and in wide ranges of current and voltage. With these instruments it is possible to determine the energy consumption of any alternating-current circuit.

In measurement of non-electrical variables (temperature, pressure, volume, pH, gas concentration, etc.) electrical measuring methods are often employed. The same is true also for the transmission of signals from the place of measurement to other locations. For direct current, the sender is a variable resistance and the receiver is a cross-coil instrument which is widely used in Germany. Remote measurements using alternating-current induction senders and receivers are also employed.

Vacuum-tube amplification. For measurement of non-electrical quantities by electrical means, an amplification of voltage (thermocouple voltage, for example) is often necessary. It is well known that the amplifier tube is usable in instruments only if changes of system voltage and tube characteristic have no effect on the calibration of the amplifier. Such amplifier tubes are found in an amplifier circuit which has been used in Germany for fifteen years in all industrial installations. This is the automatically operating *Lindeck-Rothe compensator.* In this circuit the anode current of a tube is adjusted by a mirror galvanometer over a photocell so that the voltage drop across a resistance in the anode circuit agrees with the thermo-emf. to be measured. The compensator has the disadvantage of a mirror galvanometer. However, the galvanometer is made sufficiently independent of position by a tension band suspension, and experience has proven it to be safe in operation. The advantages are (1) only a single tube is required and (2) the tube characteristic does not influence the measurement because the tube acts merely as a variable resistance.

Recorders

Chopper bar. The potentiometer recorders common in the USA have not yet found wide application in Germany, probably because the accuracy of the deflection instruments is sufficient to supervise processes. For recording small voltages, as of thermocouples, the so-called chopper-bar recorder has been employed for about twenty years. The chopper-bar recorder contains a sensitive moving-coil measuring element in which the coil is suspended on a tension band suspension. Therefore, no friction exists. The position of the pointer is scanned about every 20 seconds by the chopper-bar mechanism. The mechanism produces a series of dots on the chart by means of a colored ribbon. These recorders usually are built for recording six variables.

Pneumatic. About a year ago, recorders of low voltage (millivolts) were developed which contain a pneumatic amplifier. On the shaft of the moving-coil measuring element there is fastened a small steel tube to which air is supplied. The air is supplied axially so that no disturbing deflection occurs. A movement of the moving coil causes the air jet to hit an opening leading to a large diaphragm. Movement of the diaphragm causes a follow-up motion of the jet-pipe system. As this movement is carried out with a large pneumatic force, the diaphragm can move a recording pen.

In general, the continuous recording of thermovoltages has usually been done with a conventional electrical recorder in conjunction with the photoelectric amplifier described previously.

Gas Analysis

Many companies in the world make use of the paramagnetic properties of oxygen in measuring the proportion of oxygen in gas mixtures. In Germany, several companies build such instruments. Some of the instruments have no moving system, are corrosion-resistant, and are largely independent of the flow velocity of the gas. The smallest measuring range is 0 to 1 percent O_2. Another series of gas-analysis instruments permits the continuous measurement and recording of the proportion of the gas. These instruments are based on the conductivity, the heat development, and other properties in a chemical reaction between the desired gas constituent and a suitable liquid. Such instruments can measure small traces of gas with accuracy. It is possible, for example, to build an instrument with a measuring range of 0 to 0.02 percent H_2S, 0 to 0.05 percent O_2, 0 to 5×10^{-4} g./cu.m. H_2S, or 0 to 5×10^{-3} g./cu.m. SO_2. It is also possible to measure a small portion of non-absorbable noble gases, as for the purity test of O_2 and CO_2.

Controllers

A survey of instruments used in Germany would not be complete if the controllers were not described. In Germany as in the USA, numerous constructions exist. It is impossible to describe them all. This report must be confined to a few general remarks.

Until a few years ago there were two principal controller types used in operating installations in Germany. These were the completely pneumatic (or hydraulic) regulator and the completely electrical regulator. The term "completely" refers to the fact that both the measurement and the adjustment of the valve is made pneumatically, hydraulically, or electrically.

Pneumatic regulators have been used where the costs for the control plant must not be high. The controllers are provided with diverse stabilizing devices as in American regulators.

The accuracy of pneumatic measuring elements (mainly Bourdon spring) is not great, as is well known. If higher accuracies are required, the chopper-bar controller is used in most combustion-control processes. This type controller has a sensitive and accurate measuring element. The pointer is scanned periodically by the chopper bar, and mercury tubes are switched in accordance with the position of the indicator. Such controllers have been developed in the last twenty years to great perfection. It is now possible to use different stabilizing arrangements by switching different tubes, as with pneumatic controllers.

In recent years several German companies have developed controllers which combine the advantages of electrical measurement (high sensitivity, high measuring accuracy, transmission over great distances) with the advantages of pneumatic operation (safety from explosion, simple valve construction). These so-called "electropneumatic" controllers possess an electrical moving-coil measuring element (or, when using resistance thermometers, a cross-coil element) the pointer of which carries a deflection vane. This vane deflects either a fine air current, the pressure change of which is then amplified pneumatically, or the illumination of a photocell in the grid circuit of a tube. In the latter construction the anode current of the tube actuates an electropneumatic relay which is not in the controller but in the vicinity of the diaphragm valve. The distance between controller and valve can be great because the connection is electrical.

Another electropneumatic controller controls pressure by means of a coil moving in a magnetic field, as in loudspeakers. All controllers with electric measuring elements have the advantage that practically all variables can be controlled. This is because it usually is possible to transform the variable to be controlled into an electric potential or current.

In addition to the problem of controlling a variable at a definite value or according to a time program, there exists the important problem of controlling the ratio of two gas flows—usually the ratio of fuel gas to air in gas-fired furnaces. Particular attention is paid to this problem in Germany in order to save fuel. The two gas quantities are usually measured by baffles and differential-pressure instruments. Diaphragm-type differential-pressure instruments can be coupled mechanically to hydraulic regulators.

Another type of differential-pressure instrument uses ring balances, which are widely used in Germany. It is easy to alter their measuring range by changing the weights. A simple gas/air ratio controller contains two such ring balances connected through a small differential gear. The gear turns a circular tube containing mercury and a contact. This contact is closed by the mercury only if the two ring balances do not coincide in position. Thus the valve in the air duct is adjusted until the correct gas/air ratio is attained.

Some Impressions *of the* Automatic Control Conference Held *in* Bedford, England, July 1951

By A. J. YOUNG, Imperial Chemical Industries Ltd., London.

The Servomechanism Engineer and the Process Control Engineer have much to offer each other. A common language is needed if the benefits of cooperation are to be achieved.

UNDER the most favorable auspices there commenced on July 16th the Conference on Automatic Control sponsored by the British Department of Scientific and Industrial Research. The weather was the best an English summer could produce, and was forecast to remain so—which it actually did until the Conference ended on July 21st. The setting and accommodation at the College of Aeronautics, Cranfield, seemed to appeal to the delegates as being most happily chosen. The Presidential address by Sir Ben Lockspeiser held everyone's attention, in spite of the high temperature, and prepared the way for the week's discussions.

The conference did not belie the promise of the auspices. It was generally agreed to be a great success from beginning to end and everyone felt that the Organizing Committee had done a splendid job. At the farewell dinner, a succession of speakers from the many different countries represented made a particular point of expressing their gratitude to the Chairman of the Organizing Committee for all the hard work and inspiration he had put into the Conference. The Chairman was Professor A. Tustin of Birmingham University.

It is the purpose of this article to review the likely results of the Conference in the process control field and to give one impression of the importance of these results.

The Aims Of The Conference

The objectives were quite clear; namely, to further progress in the whole field of control theory and practice and to provide an opportunity for closer contact between workers in different parts of that field. Two important groups, working in different parts of the field, are the servomechanism and the process control engineers. But there is no doubt that even within these large groups, many smaller groups and perhaps even individuals normally work without much chance of sitting back to consider the wider horizons and of discussion with others with different but related interests.

This is a statement which applies, and accounts for, the majority of conferences. However, there was a special aspect of it in this instance, because a whole major group, the process control engineers, have been very much out of touch with the work of another major group, the servomechanism engineers. Yet the developments in the latter, and the well-established techniques which it has produced for tackling control problems in general, can hardly fail to be of great value to the former.

Servo Techniques To Solve Problems

Different though the two sorts of problem are, their solutions are based essentially on knowledge of the properties of "closed-loop" systems. The practical difficulties raised in process control by our scanty knowledge of process characteristics, by the unknown dynamic characteristics of actual plant are, of course, both formidable and at the same time foreign to the servo problems in gun laying, predictors and so on. The large-number production of equipment especially designed to meet one particular specific problem is equally foreign to process control, for which one of a limited series of general-purpose units must be chosen (except in special cases) for each application. These and a dozen other differences being granted, it still seems quite obvious that the very difficulties they present demand every available technique to overcome them.

There is, in addition, the important consideration that the solution to some process problems may already exist implicitly in the other field, or more probably that if the servo specialists know of the existence of the problems they might apply their own tools to solving them.

It was with such thoughts in mind that Professor Tustin conceived the idea of a joint conference for both sorts of engineers and called a meeting of some of them a year ago to discuss the whole problem as a preparatory step.

The views which were crystallized then were presented to the conference in a paper[1], but the encouraging fact is that even before the paper was read, a good start had been made by some workers outside the process field in attacking the problems. Nevertheless a great deal remains to be done and it is strongly hoped that among the many who will read this paper when it is published[2], some with the servo techniques ready to hand will take up the challenge it offers.

Chemical Engineers And Plant Designers

Although two groups in the control field have been mentioned, there are others which the conference sought to interest in process control. Perhaps the most important of these is that containing all those who, under different names and guises, are responsible for designing plants.

It may not be too optimistic to say that, in general, the day has passed when a plant was designed (and sometimes built!) before any thought was given to its instrumentation. The proper location of primary elements and regulating units is certainly considered now and generally some thought is given to the system as a whole, in a qualitative way, to make the plant as easy as possible to control. At the same time it is quite certain that few attempts have been made to design plants—or even plant units such as heat exchangers, boilers, or stills—for optimum controllability on a quantitative basis.

If designers did ask for detailed guidance at the present time, most of us could at least give only general rules and indications. First the dynamic characteristics of the plant and its units must be known.

Hence the importance of Takahashi's paper[3] on the analysis of the more important generalized types of heat exchangers, to establish their dynamic characteristics relevant to controllability. The paper is very concise and complete. It presents in graphical form the results of an enormous amount of computation work to find the thermal characteristics of the various types of exchangers, and their response to sinoidal and transient disturbances. The paper ended with a brief description of experiments with a model exchanger and a proportional and integral controller which gave results in support of the theoretical findings. Following the work of Profos[4] on the design of boiler superheaters for better controllability, Takahashi's paper has certainly carried us a stage nearer to an accurate prediction of plant characteristics, and so towards the ultimate aim of process engineers—plant design for controllability.

The whole point of emphasizing the importance of this aspect, of course, is to show how vital it is that chemical engineers and plant designers take an interest in the problem and collaborate with the control engineer.

In this connection it might be interesting to report that an instrument[5] was demonstrated, during the Conference, which was designed for obtaining plant characteristics by frequency-response methods, on operating full-scale plant.

Education of the Control Engineer

It is hardly logical to leave the thesis of collaboration between servo, process control, and plant-design engineers without examining the basic fact which alone determines the possibility of effective collaboration between any groups in any field of activity; namely, an ability to speak the same language or to find adequate and sufficiently numerous interpreters.

The language of the servo engineers is quite international, but very exclusive. It is the language of advanced mathematical conventions and it is not given to everyone to possess the mathematical talent or the necessary opportunity of developing it.

The Specialists for Development of Theory and Practice.—It is clear that those who will *develop* the theory of control must have both the talent and the opportunity. Moreover the opportunity must include experience in using and acquiring versatility in applying the mathematical techniques in question. This is easy to provide in the servo field "on the job" with the team the new recruit joins in probably a large department. It is not at all easy in the process field, where so few development workers with the necessary experience are to be found.

Two possibilities seem worth considering. First to give the recruit his training in the servo field; the second to arrange the type of post-graduate course that Professor Gordon Brown inaugurated at M.I.T. and described in the paper[6] which he read on the opening day of the Conference. In this course the post-graduate engineer can learn by experience on a full-size project and by rubbing shoulders with his fellows on the team and by getting the experienced guidance and advice of his supervisor.

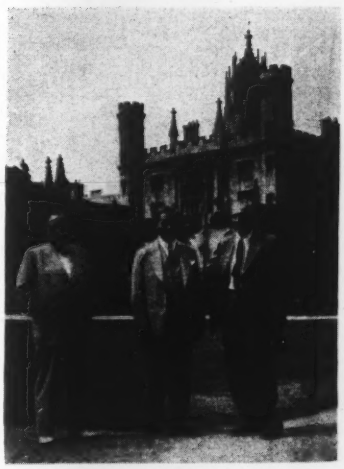
The first possibility has so far not materialised to any extent and it is perhaps not reasonable to place much hope in it. The second is not only a possibility, but a tried actuality in the U.S.A. Other countries are not so well placed.

In the discussion following this paper, Professor Hayes of the Military College of Science (England), seized upon this point and made the apt proposal that in England the post-graduate students in this field could, at least, be gathered together in a few engineering schools. At present they are scattered throughout the Universities in ones and twos.

It is important to remember that the number of "specialist" development men required are only a few per year. Each large industry needs, at present and probably for a very long time to come, only a few at one time.

The Interpreters.—To a large extent the specialists can also be the interpreters—passing on in a clear form the information they extract from the servo field, or from their own work. There will always be others to help in this vital function, but obviously they too must understand the language.

Before leaving the subject of education, it should be said that Gordon Brown's paper raised wider issues than the education of control engineers as such. It put forward very wide claims for the value to industry, and indeed to society, of the man well educated in "feedback systems engineering," to use the terminology of the paper. The issues are quite beyond the scope of this article; the paper will make very interesting reading.



Pictured in front of St. John's College, Cambridge, are Richard Rimbach (left) publisher of INSTRUMENTS. Larry Yoxall (center) of Foxboro-Yoxall (England), and William Howe (right) of Foxboro Company (USA). The men were in attendance at the British Conference on Automatic Control.

The Application Engineers and Plant Designers.—Even if the education of the specialist is provided for, it still remains to spread knowledge of the basic principles and of new developments in application and plant design technique through the far more numerous ranks of the application engineers and plant designers. They already have enough to crowd into their courses; the solution is not a post-graduate specialist course, for many reasons. The problem is the old one, of how to put a pint in a half-pint pot.

The Practical Significance of the Conference Papers

The papers of direct interest to strictly process engineers fall into three categories: analysis of plant and controller characteristics in general, analysis and experimental work on measurement and transmission lags (mainly in flow control) and treatment of the problems in discontinuous control.

Plant and Controller Characteristics

In the first category the papers of A. R. Aikman and C. I. Rutherford[7] and Janssen[8] are concerned with the analysis of controller characteristics. Both authors used frequency response methods and, considering that the work was done in England and Holland independently, the two approaches were remarkably similar up to a point. They agreed in emphasizing the interaction between the actions of a three-term controller of the conventional design and upon the importance from a practical point of view of recognizing the existence of this interaction, and its quantitative significance. In fact the authors only disagreed on the method of presentation of the factor in the equation describing the controller characteristics.

Aikman and Rutherford proceeded to derive the equations for some of the well-known proprietary controller designs and gave the important ratios of integral to derivative action times (for each design) which would be likely to give optimum results for most plants.

This paper was intended to follow up the earlier paper by C. I. Rutherford[9], which described the application of frequency response methods to this investigation of controllers. The data given in the conference paper should prove extremely useful to plant engineers in setting up new controller installations.

Janssen on the other hand amplified his theoretical treatment with explanations of the practical limitations to the adherence of actual controllers to the performance expected when certain assumptions are made to simplify theoretical analysis. He discusses the effect of change of controller output pressure on the action of the controller (due to change in pressure and hence flow rate in the restrictors), the effects of ignoring finite volume changes in the bellows, the effect of time lag in the controller itself and of the "finite amplification" of a controller (as also pointed out by Aikman and Rutherford). The limitations imposed by these effects are well-known to the majority of instrument makers. They gave rise to a certain amount of discussion which lead to an apparent general agreement that, in the normal case, they were not very serious handicaps in practical application. At the same time it is a good thing that they are now stated, with their causes, as a warning not to extend the approximate theory to cases in which it does not apply.

The two papers are chiefly valuable for two reasons: they put the whole matter of controller performance on a sound quantitative basis, and they should help designers to produce equipment to meet definite performance specifications. In particular they stress the importance of having calibrated action times which remain consistent and reproducible in use. Without this, the data given cannot be used.

A very interesting fact reported in the discussion was that a pneumatic three-act.on controller had been de-

Continued on page 1216

Instrument Electronics

By M. H. ARONSON, Managing Editor, *Instruments*

III. IMPEDANCE AND RESONANCE

Impedance

AN IMPORTANT characteristic of any element in an electrical circuit is its opposition to current. In circuits, voltages are produced by batteries, generators, or signal sources. The currents that flow because of the voltages depend on the opposition of the circuit elements (Ohm's law).

There are 3 basic kinds of opposition—resistance, capacitive reactance, and inductive reactance. Resistance is the opposition (in ohms) of a resistor to both d.c. and a.c. Capacitive reactance is the opposition of a capacitor (in ohms) to a.c. Inductive reactance is the opposition (in ohms) of an inductor to a.c. Most circuits have resistance, capacitance, and inductance. In fact most circuit elements have some of each type opposition. Thus the total opposition of an element or circuit is the sum of its resistive, capacitive, and inductive oppositions. This total opposition (to a.c.) is called *impedance*.

Methods of Determining Impedance

Ohm's Law

A basic method for determining the impedance of any electric device is to apply an a-c. voltage (E) *across* the device and measure the current (I) *through* the device. From Ohm's law, the impedance is

$$Z = E/I.$$

Characteristic Curve

It is common practice to apply d-c. voltages across an element, to measure the direct current through the element for several applied voltages, and to plot the results. Such plots are called *characteristic curves*.

Fig. 3-1,A shows such a plot for resistors. Curve 1 is a low resistance. Note that a low voltage causes a high current. Hence the slope of the curve is steep. Note also that the slope never changes. Curve 2 is a higher resistance. Note that the slope is smaller. Curve 3 has a negative slope. Although no resistor has this response, the response occasionally is encountered in certain circuit elements. A device with a negative-slope response is called a *negative resistance*. Note that current increases as voltage decreases across a negative resistance.

The *slope* of the curve is significant in that it tells how the element reacts to a.c. A steep slope signifies a low resistance to a.c. A flat or small slope signifies a high resistance to a.c., or high impedance. (The slope is a measure of the a-c. resistance, or impedance, because the slope at any point equals a small *change* in voltage divided by the resultant small *change* in current.)

Fig. 3-1,B is a response curve for a rectifying element such as a diode. Note that the slope is constant and steep between points X and Y. Hence the diode has low d-c. resistance and, further, has low impedance to a.c. For negative voltages, however, the resistance (E/I) of the diode is infinitely large. As the slope is zero, the impedance is large also. This is why a diode rectifies, as will be explained later. As the slope becomes zero above Y, the diode has high impedance in this region although the d-c. resistance is low.

ANSWERS TO QUIZ II (PART 2)

2-27. (d)	2-33. (a)	2-39. (c)	2-45. (c)	2-51. (a)
2-28. (c)	2-34. (c)	2-40. (d)	2-46. (a)	2-52. (d)
2-29. (b)	2-35. (a)	2-41. (c)	2-47. (a)	2-53. (c)
2-30. (c)	2-36. (c)	2-42. (d)	2-48. (b)	2-54. (c)
2-31. (d)	2-37. (c)	2-43. (c)	2-49. (c)	2-55. (a)
2-32. (b)	2-38. (c)	2-44. (a)	2-50. (b)	2-56. (b)

Test items for—III Impedance and Resonance—page 1206.

Note that although the ratio of E to I at any point on a characteristic curve is the d-c. resistance of the device at that point, the slope tells how the device reacts to a.c. Note also that the d-c. and a-c. resistance of a device can be different.

A resistor has a straight-line characteristic curve because the resistance does not depend on the size or polarity of the applied voltage. Many other circuit elements (vacuum tubes, varistors, etc.) have nonlinear characteristics—that is, the resistance varies. Characteristic curves are extremely useful in that they make it possible to determine how the element reacts to any applied voltage.

Calculation by Vector Addition

When resistors, capacitors, and inductors are in series or parallel, it often is desired to calculate the impedance.

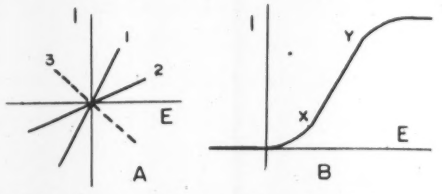


Fig. 3-1. Typical characteristic curves made with d.c. A, response of resistors; B, response of a rectifying element such as a diode or crystal.

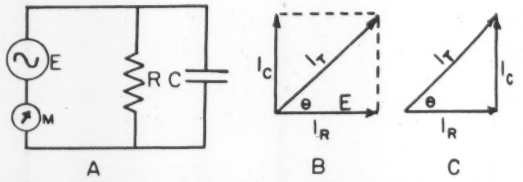


Fig. 3-2. Generator connected to a resistor and capacitor in parallel. A, circuit; B, phase relations of currents showing currents added by parallelogram method; C, phase relations showing currents added by triangle method.

Although impedance is the sum of resistance and reactance, and although resistance and reactance are measured in the same units (ohms), they cannot be added algebraically because they are not exactly alike in phase. Out-of-phase variables can not be added algebraically. For example, if an a-c. voltage (E) is applied across a resistor (R) and a capacitor (C) in *parallel* (Fig. 3-2), the current through the resistor and that through the capacitor are out of phase—that is, they are not zero at the same instant. Therefore, the currents in each branch cannot be added algebraically to give the total generator current.

Suppose that E in Fig. 3-2 is 1 volt, that R is 1 ohm, and that X_C is 1 ohm (at the frequency of the generator). From Ohm's law, I_R is 1 amp., and I_C is 1 amp. However, the ammeter (M) in series with the generator reads 1.414 amp. This shows that the currents must be added vectorially, not algebraically. In order to add vectors vectorially, you draw the vectors with proper length and direction and then either complete a parallelogram (Fig. 3-2,B) or a triangle (Fig. 3-2,C). The diagonal of the parallelogram, or the hypotenuse of the triangle, is the *vector sum* of the two vectors. As the length of the hypotenuse of a right triangle equals the square root of the sum of the squares of the sides, the formula for generator current (I_T) is:

$$I_T = \sqrt{(I_R)^2 + (I_C)^2}$$
$$= \sqrt{1+1} = \sqrt{2} = 1.414 \text{ amp.}$$

To find the impedance of the parallel circuit, this formula can be used to find the total current. Once the

total current is known, the impedance of the resistor and capacitor circuit is found from Ohm's law:

$$Z = E/I_T$$

Note that the generator current leads the applied voltage by 45 degrees. If the capacitor in the circuit is replaced by an inductor with a reactance of 1 ohm, the reactive vector points downward; the generator current remains the same in value but lags the applied voltage by 45 degrees. The phase angle, which is the angle between generator voltage and current, is marked θ in Fig. 3-2.

Elements in series. Fig. 3-3,A shows a resistor and capacitor in series. As the circuit is a series circuit, the current is the same at all points in the circuit. However, the voltage drop across the resistor (E_R) is out of phase with that across the capacitor (E_C), as shown in Fig. 3-3,B. The vector addition of E_R and E_C shows that the applied voltage (E) lags the current (I) by θ degrees, as is expected. Fig. 3-3,C shows the same vector addition except that E_R is labeled IR, E_C is labeled IX_C and E is labeled IZ. As I is common to all three sides of the figure it can be dropped, giving the *impedance triangle* shown in Fig. 3-3,D.

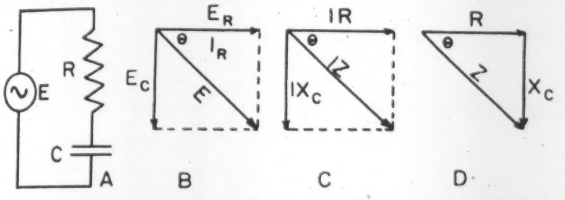


Fig. 3-3. Resistor and capacitor in series with generator. A, circuit; B, phase relations of voltages in circuit; C, vector diagram relettered; D, impedance triangle.

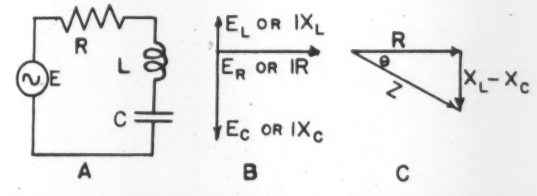


Fig. 3-4. Series circuit with resistance, inductance, and capacitance. A, circuit; B, phase of voltage drops in circuit; C, impedance triangle.

From Fig. 3-3,D, it is seen that

$$Z = \sqrt{R^2 + (X_C)^2}$$

If the series circuit contains resistance, capacitance, and inductance, the vectors are as shown in Fig. 3-4. Note that X_L and X_C both are vertical and, therefore, can be subtracted from each other directly. This leads to the formula for the impedance of a series circuit containing resistance, capacitance, and inductance:

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

Power Factor

It has been shown that when current flows through a resistor, there is a power loss of EI, or I^2R, watts. When current flows through a reactance, the current and voltage are 90 degrees out of phase and there is no power loss. Thus the *true power* supplied to a circuit depends only on current and resistance, and equals $E_R I_R$, or $I_R{}^2R$. Note that E_R (the voltage across the resistor) and I_R (the current through the resistor) are always in phase.

As the resistance of circuits which contain reactance can not be measured easily, most power measurements are made by measuring the applied voltage (E) in rms. volts, and the circuit current (I) in rms. amperes. The product of E and I is the *apparent power*. However, if the circuit contains reactance, the product EI is not the true power because E and I are out of phase. The true power is $E_R I_R$, or $E_R I$ because I_R is I in a series circuit. From Fig. 3-3,B:

$$E_R = E \cos \theta$$

Therefore, the true power (P_T) is

$$P_T = E_R I = EI \cos \theta$$

Cosine θ is called the *power factor* because it is the factor by which the apparent power must be multiplied to find the true power.

Power factor $= \cos \theta =$ *true power/apparent power.*

The power factor often is expressed in percent. For example, if θ in Fig. 3-3 is 45 degrees, cosine θ is 0.7071, and the power factor is said to be 70.71 percent *leading*. The phase angle is said to be leading because current leads voltage in the capacitive circuit shown.

Impedance Matching

To obtain the greatest transfer of energy from one circuit to another, the impedance of the two circuits must be matched. Consider the transfer of power from the battery in Fig. 3-5 to the resistive load. Assume that the 1.5-volt battery has an internal resistance (R_E) of 1.0 ohm, and that the load resistance (R_L) is 0.5 ohm. The total resistance of the circuit is 1.5 ohms. The current flowing in the circuit is 1.5/1.5, or 1 ampere. The potential developed across the load is 1 times 0.5, or 0.5 volt. The power (EI) developed across R_L is 0.5 times 1.0, or 0.50 watt.

If the load resistance is increased to 1 ohm, the total resistance of the circuit is 2.0 ohms, the current in the circuit is 0.75 ampere, and the power developed in the load

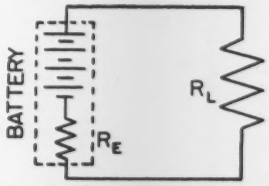


Fig. 3-5. Battery with internal resistance (R_E) supplying current to a load resistor (R_L).

is 0.56 watt. Table V shows the power developed across the load for various load resistances. Note that the power developed in the load resistance is greatest when the load resistance equals the internal resistance of the power source.

TABLE V.—POWER DELIVERED TO LOAD FOR DIFFERENT VALUES OF LOAD RESISTANCE

Source Resistance	*Load Resistance*	*Load Voltage*	*Load Power*
1.0 ohm	0.5 ohm	0.5 volt	0.50 watt
1.0	1.0	0.75	0.56
1.0	2.0	1.0	0.50
1.0	4.0	1.2	0.36

This may appear strange because at the point of maximum power transfer, the voltage across the load is only 0.75 volts, whereas for higher load resistances the voltage is greater. However, the reason is obvious. Power depends on the *square* of current (I^2R). When the load resistance is high, the current and power are small, even though the voltage is high. When the load resistance is smaller than the source resistance, the large current causes excessive voltage drop across the internal resistance of the source, leaving only a small voltage across the load. When the load resistance equals the source resistance, the power transfer is maximum.

Similarly, the maximum transfer of power in an a-c. circuit occurs when the impedance of the load matches the impedance of the generator. For example, suppose you wish to use a power-amplifier tube to drive a motor in a recorder. A power amplifier has an internal impedance (plate a-c. resistance) on the order of 1,000 ohms, whereas the motor impedance can be on the order of 100 ohms. Therefore, some impedance-matching device should be used between the two for maximum transfer of energy. This usually is done by a transformer with the proper turns ratio. The transformer is the most common impedance-matching device because any ratio of impedance can be obtained by selecting the turns ratio, as explained previously.

Continued on next page

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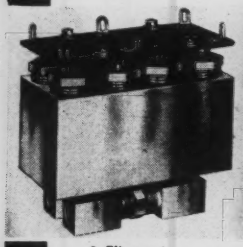

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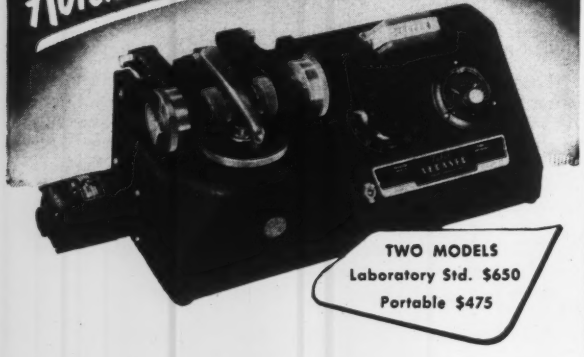

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INSTRUMENT ELECTRONICS

Continued from preceding page

Resonant Circuits

As shown in Fig. 3-4, capacitive and inductive reactances are exactly opposite in nature. As they are exactly 180 degrees out of phase, they can be subtracted algebraically. An interesting circuit is one which contains exactly equal amounts of capacitive and inductive reactance. As the reactances cancel each other, the total reactance of the circuit is zero. Large currents can be caused by small voltages in such circuits. Circuits in which the inductive reactance equals the capacitive reactance are called *resonant* circuits.

Series Resonance

Fig. 3-6,A shows a series-resonant circuit—that is, an inductor, a capacitor, and a resistor in series. As explained previously, the impedance of this series circuit is

$$Z = \sqrt{R^2 + (X_L - X_C)^2}.$$

At the frequency where X_L equals X_C, the impedance becomes only the resistance, which can be small. In most resonant circuits, this resistance is only the d-c. resistance of the wire in the coil.

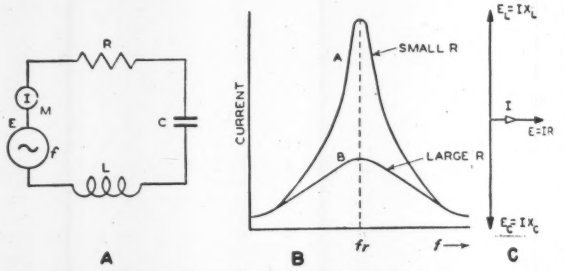


Fig. 3-6. Generator connected to a series-resonant circuit. A, circuit; B, current in circuit at various frequencies; C, phase of voltages in circuit.

Resonant frequency. The circuit is said to be resonant at the frequency where X_L equals X_C. In either a series-resonant or a parallel-resonant circuit with fixed values of L and C, there is only one frequency at which resonance occurs. As $X_L = 2\pi fL$, and as $X_C = 1/2\pi fC$, resonance occurs when

$$2\pi fL = 1/2\pi fC.$$

Therefore, the resonant frequency of a circuit containing L and C is

$$f = 1/2\pi\sqrt{LC}$$

Consider the action of the circuit if the generator frequency (f) is raised from a low frequency to a high frequency. At frequencies below resonance, X_L is insignificant and the circuit is like a resistor plus a capacitor. At resonance, X_L and X_C cancel, and the circuit is like a resistor only. At frequencies above resonance, X_C becomes insignificant, and the circuit is like a resistor and an inductor. Fig. 3-6,B is a graph of current versus frequency. Note that the current reaches a peak at the resonant frequency (f_r)—that is, the circuit impedance is a minimum at resonance. The peak current at resonance is limited only by the resistance, as shown in Fig. 3-6,B.

An interesting fact is that the voltage across the capacitor (E_C) and across the inductor (E_L) can be much greater than the applied voltage. This is because the large current (I) causes large potentials (IX) across the reactances. As IX_L is opposite to IX_C, they cancel each other and only IR is measured across the generator. However, a voltmeter across L or C measures a much larger voltage at resonance. The voltages are shown in Fig. 3-6,C. Note that the capacitor rating must be higher than the generator output voltage.

The graph of current against frequency is called a *resonance curve.* Note that if the total resistance of the circuit is large, the resonance curve is broader and flatter

than if the total resistance is small. The circuit which curve A represents is said to be more *selective* than the circuit represented by curve B. This means that a circuit with curve A is better able to discriminate against frequencies on either side of resonance. This property of the series-resonant circuit often is used to pass current of a certain frequency and to reject currents of other frequencies.

Q.—A factor known as *Q* is used to show the sharpness of resonance of a tuned circuit. This factor usually is expressed as the ratio of the inductive reactance of the coil at resonance to the resistance of the coil, as follows:

$$Q = X_L/R = 2\pi fL/R.$$

The *Q* of resonant circuits ranges from 20 to 100 for iron-core coils and to 30,000 for silver-plated resonant cavities. Another way of defining *Q* is to say that it is a comparison between the total power in a tuned circuit and the power which is dissipated by the resistance in the circuit. The resistance should be kept as low as possible in order to realize high efficiency. In practice, as nearly all the resistance of a resonant circuit is in the coil, the ratio of the inductive reactance to the resistance of the coil is especially important. The higher the *Q* of a coil, the better the coil. Note that the *Q* of a coil varies with the frequency at which it is measured.

Parallel Resonance

A parallel-resonant circuit consists of an inductance and a capacitance in parallel (Fig. 3-7). The resistance

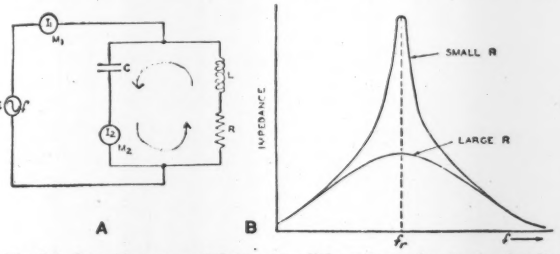


Fig. 3-7. Generator connected to a parallel-resonant circuit. A, circuit; B, impedance of circuit at various frequencies.

shown is the resistance of the coil, which can not be eliminated. In the parallel circuit, the main-line current is minimum at the resonant frequency. This is the same as saying that the impedance of the circuit is high at resonance. The impedance at resonance of a parallel circuit is expressed by

$$Z = (2\pi fL)^2/R.$$

The impedance of a parallel-resonant circuit can be expressed also as a function of *Q*:

$$Z = 2\pi fLQ.$$

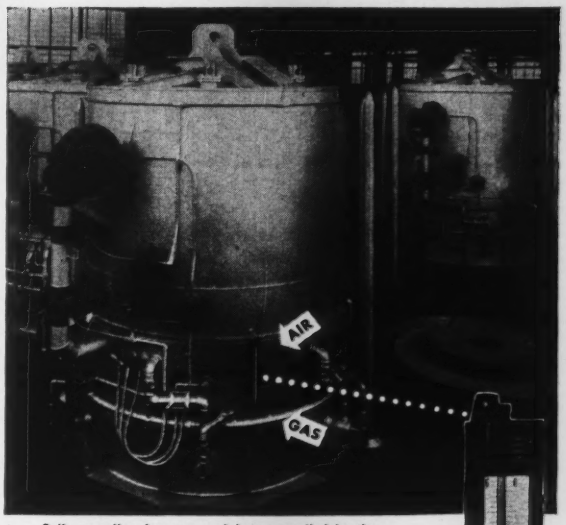
This formula shows that the impedance of such a circuit is directly proportional to its *Q* at resonance.

Note that the impedance across the terminals of a parallel circuit is *maximum* at resonance, whereas it is *minimum* for the series circuit. As in the series circuit, the resonance curve is sharper when the resistance is smaller.

In Fig. 3-7, the two meters (M_1 and M_2) indicate the two currents which are important in parallel-resonant circuits. The *line current* is read by M_1; the *circulating current*, which circulates only within the parallel-resonant L-C circuit, is read by M_2. As the inductive and capacitive reactances are equal at resonance, the currents through the two also are equal and are opposite in phase. They cancel each other in the external line circuit and, therefore, M_1 indicates a low current at resonance. There would be zero current in the line at resonance except for the fact that the resistance of the inductor causes the phase angle to be slightly less than 90 degrees in this branch so that complete cancellation cannot take place.

Even though the line current is small, the circulating current shown on M_2 can be quite large. In a parallel-resonant circuit, therefore, the impedance at resonance

Continued on page 1206



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"Stratosphere" Test Chamber

CAMDEN, N. J.—"All the world's weather" is said to be available in a single room 14 feet square and 10 feet high in the testing laboratory of the RCA Engineering Products Department here. This 50-ton $150,000 chamber was installed for testing all kinds of electronic equipment under conditions to which it may be exposed in use. With it, laboratory personnel can simulate all temperatures, humidities, and atmospheric pressures found on or above the earth, to an altitude of 70,000 feet above sea level.

Here, every device made by RCA for military or civilian use in far-away places, from airplane transmitters to walkie-talkies, can be tested under conditions prevailing in the Sahara or Siberia, in the jungles of the South Pacific or atop the Himalayas.

Known as a "stratosphere chamber," it can reduce atmospheric pressure to the level encountered at an altitude of 70,000 feet, which is higher than the accepted altitude record for airplanes and almost as high as man has ever ascended in a balloon. The partial vacuum reduces a 29-inch column of mercury to one inch.

Heating and refrigeration equipment within the chamber can create temperatures from 185 F. to minus 85 F. To provide refrigeration for the unit requires 180 horsepower, enough to run 720 8-cubic-foot domestic refrigerators simultaneously.

Humidity within the chamber can range from a heavy fog to almost complete lack of moisture.

Because of its size and weight, the chamber, which cost $150,000, posed a number of installation problems. It was built in three sections and transported to this city from Newark, N. J., by trailer-truck. Because the chamber overhung the trailer three feet on each side, creating a traffic hazard, special approval from the State Highway Department was necessary, and the trip was made in the early hours of the morning, when traffic was light. The three sections weighed 11, 17, and 21 tons, respectively. In order to get them into the laboratory, a wall area measuring 18 by 20 feet had to be removed from the building.

The door of the chamber weighs about two tons, is moved into place on rollers, is air-sealed by means of powerful air cylinders fixed on each corner.

To enable the chamber to withstand the external pressure when the vacuum system is in use, 12-inch steel channel sections on 12-inch centers reinforce the entire outside surface. An inner wall of 9-inch-thick insulation is used to maintain temperatures. The inside of the chamber is finished in stainless steel to reduce corrosion.

"Knows All Angles"

FORT BELVOIR, Va.—A simple device that shows all the angles—on photographs—has passed operational tests at the Engineer Research and Development Laboratories. The new photoangulator, as it is called, accurately gives true horizontal directions from oblique aerial photographs.

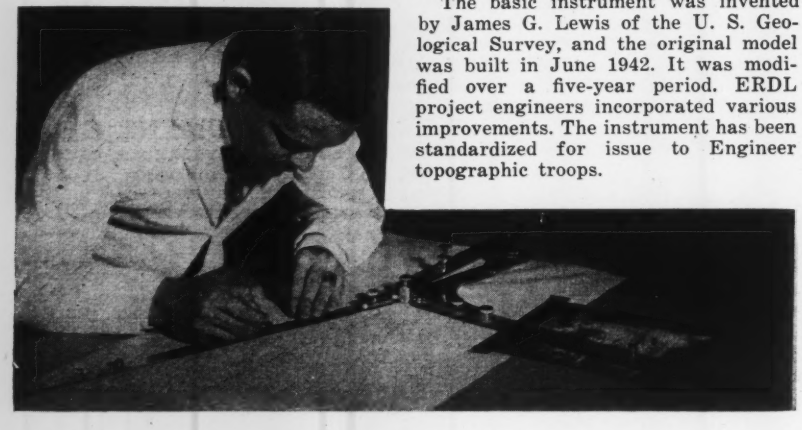
Military aerial photographs, used in the production of most aeronautical charts and small-scale mapping (a prime source of reliable intelligence) are made with three cameras that simultaneously shoot one vertical and two oblique photographs, thus covering a wide area. With the aid of the photoangulator, a network of intermediate horizontal control is established from the oblique photographs to which the map is compiled.

There are three principal parts to the instrument: (1) a depression angle assembly for adjustment to the depression angle of the aerial camera at the instant of exposure; (2) a transparent photo arm under which intermediate control points are intersected on the photo; (3) a templet arm that juts over the map manuscript and gives the true horizontal directions.

A specially-designed plastic slide-rule calculator enables the operator to obtain quickly the correct photo arm setting. The entire outfit can be securely carried in a weatherproof hardwood case 25½ inches long. Total weight is 14½ lbs.

Horizontal directions may be produced from 6-inch focal length photography with camera tilts ranging from 40 to 72 degrees. The equipment can be satisfactorily used with a minimum of operating training. It is not affected by wide temperature changes and the materials are normally resistant to tropical conditions.

The basic instrument was invented by James G. Lewis of the U. S. Geological Survey, and the original model was built in June 1942. It was modified over a five-year period. ERDL project engineers incorporated various improvements. The instrument has been standardized for issue to Engineer topographic troops.



CAA Launches DME Program

NUTLEY, N. J.—A meeting to acquaint representatives of the nation's major airlines with the Distance Measuring Equipment Familiarization Program on the Chicago-New York airway, where ground DME was recently installed by the Civil Aeronautics Administration, was held here August 10 at the Federal Telecommunication Laboratories, Inc., research associate of the International Telephone and Telegraph Corporation.

Representing an outstanding development in aerial navigation, the DME, in conjunction with the CAA's omnidirectional radio range, will enable the pilot of an aircraft, for the first time, to know his exact position at a glance relative to a fixed ground position without guesswork or computation. It will greatly facilitate traffic control and increase the safety of airline operation.

See pages 1180, 1210, 1212 and 1214 for more "Instruments on the March"

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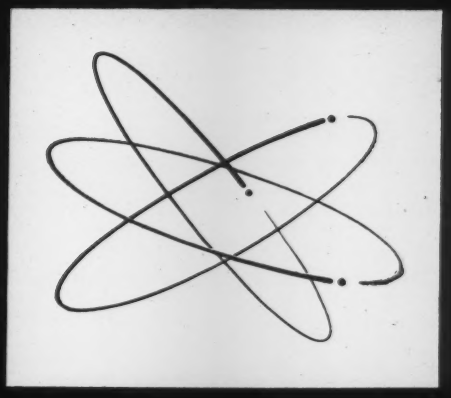

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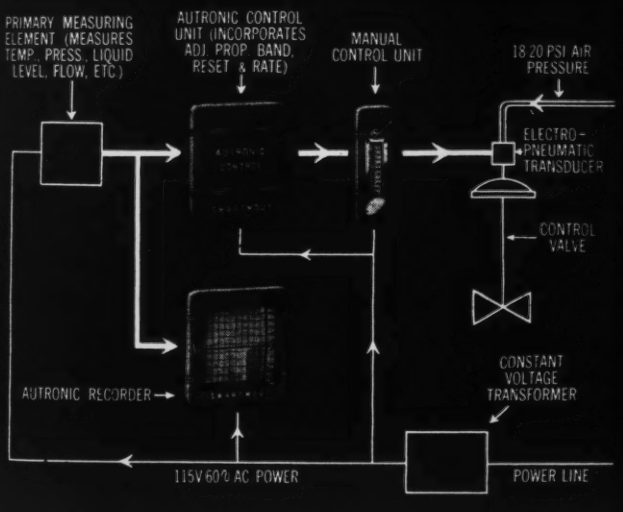

PRIMARY MEASURING ELEMENT (MEASURES TEMP., PRESS., LIQUID LEVEL, FLOW, ETC.)
AUTRONIC CONTROL UNIT (INCORPORATES ADJ. PROP. BAND, RESET & RATE)
MANUAL CONTROL UNIT
18-20 PSI AIR PRESSURE
ELECTRO-PNEUMATIC TRANSDUCER
CONTROL VALVE
AUTRONIC RECORDER
CONSTANT VOLTAGE TRANSFORMER
115V 60~ AC POWER
POWER LINE

The new Swartwout Autronic Control System brings new speed, new accuracy to your process controls. Without mechanical motion of any kind this new *all-electronic control system* spans distance between primary element and control element *without interval.* Measuring . . . analyzing . . . correcting —the Autronic System keeps your process on stream . . . assures quality product by controlling pressure, temperature, flow and level properly, instantaneously *without cycling, drifting, shifting.* Call in our engineering representative to explain how Swartwout Autronic Controls will bring new accuracy to *your* process and power instrumentation and control. Or write *today* for literature on the new Swartwout Autronic Control System.

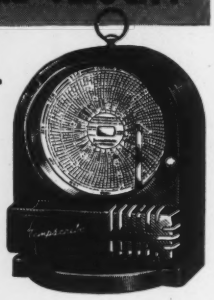
A-4578

Swartwout *Autronic* CONTROL SYSTEM

THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12, OHIO

Instruments for Measuring AIR TEMPERATURE and VELOCITY

TEMPSCRIBE
Recording Thermometer



Available in 10 different ranges to cover −30°F to +160°F temperatures, and with spring-operated chart drives for any of the following chart rotations: 8 hours, 24 hours or 7 days.

This entirely self-contained, compact and reliable temperature recorder automatically writes a continuous record of temperature changes on a replaceable chart. Record shows at a glance maximum and minumum temperatures and the duration of temperatures above or below any given point; also shows the exact time of every temperature change and how rapidly it takes place. Recording pen and bi-metallic element are built in hinged, removable door which is also front of instrument. Thus, by merely changing doors it is easy to interchange temperature ranges. Instrument is 8" tall, 5½" wide and 4½" deep. Charts are 4½ inches in diameter.

Write for Bulletin I-715

FLORITE Anemometer

In principle, this unique instrument operates as an anemometer but provides instantaneous, direct readings of air velocity without timing, calculations or reference to charts. Readings are obtained by holding the instrument in the air stream so that air blows against its circular face, causing rotation of a multi-blade rotor mounted in instrument housing. The circular scale surrounding the rotor instantly turns to correct air velocity reading under an index pointer on scale window. Furnished with detachable handle (not shown) and leather case.

Available in two styles: One with a scale of 0-1000 ft./ min., and the other with a double scale of 0-3000 ft./min. and 0-35 miles per hour.

Write for Bulletin I-760

BACHARACH Industrial Instrument Co.

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212 PAGE

CATALOG

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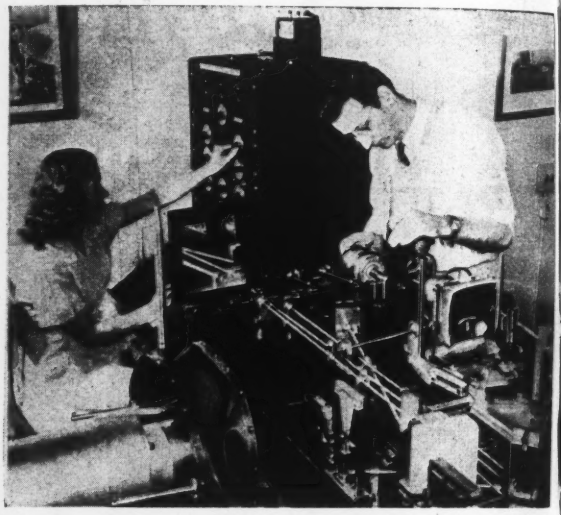
INSTRUMENTS ON THE MARCH
New Principles, Applications, and Non-commercial Developments

See also pages 1178, 1210, 1212, and 1214

Remote Control of Mechanisms in Vacuum Chamber

BEACON, N. Y.—Moving the internal parts of an infrared spectrograph while they are in a high vacuum is a new use of synchros at the Beacon, N. Y., laboratories of The Texas Company. These devices are ordinarily used to indicate angular motion at a distance from the object



which is moved. This is believed to be their first application to initiate controlled motion in a vacuum. The spectrograph is used extensively to identify complex hydrocarbon mixtures. In operation, the working parts shown here are enclosed in a large steel case which is pumped down to a vacuum of the order of 0.02 mm. of mercury to eliminate the absorption effects of air in the path of the infrared radiations. The synchros enable the operator to adjust the prisms and mirrors while they are under this high vacuum.

Tunnel Instrumentation

PITTSBURGH, Penna.—Motorists using the new vehicular tunnel under the Elizabeth River between Portsmouth and Norfolk, Va., will be protected against carbon monoxide fumes by sensitive instruments that detect one part of the deadly gas in a million parts of air. The instruments, MSA Carbon Monoxide Recorders, will be installed to analyze air samples from the tunnel.

One MSA CO Recorder is to be used for each of the two parallel 4000-foot tunnels. Air samples are drawn from strategic locations in the tunnels to the instruments located in the control room. In the equipment, the air is dried and then enters a chamber containing "Hopcalite"—a granular chemical that causes oxidation of carbon monoxide to carbon dioxide.

The instruments are calibrated so that variations in the amount of heat show accurately the percentage of carbon monoxide present in the air samples. No other common gases or vapors in the tunnels can affect operation of the instruments. When the instruments detect concentrations of carbon monoxide approaching a predetermined limit,

Continued on page 1210

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on Every Application

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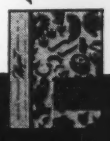
Look to INDIANA—world's largest producer of permanent magnets—for quality . . . for skill in manufacture . . . for cost-cutting engineering aid in modern magnet use . . . for know-how that comes from more than 30,000 different applications. Write today!

24-hour service on stock magnets! Write for Catalog 11-4D



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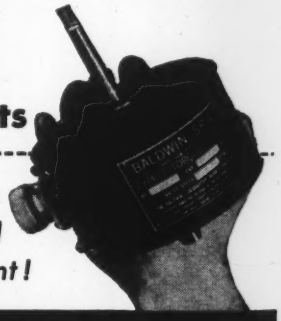
. . . without Heavy Dynamometer and Scale Equipment!



Baldwin SR-4® Torquemeter

Small, precise, rugged. Consists of short length of shaft with SR-4® strain gages bonded to it, plus slip rings and housing. Translates torsional stress into electrical energy for indicating, recording, control or limiting instruments. Available in eight standard ranges: 0-100, 0-200, 0-500, 0-1000, 0-2000, 0-5000, 0-12,000, 0-30,000 in. lbs. Calibration inaccuracy not more than ±¼% of full range in either direction at any point from 0% to 100% capacity. For full dimensional and operational details ask for Bulletin 328.

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Philadelphia 42, Pennsylvania
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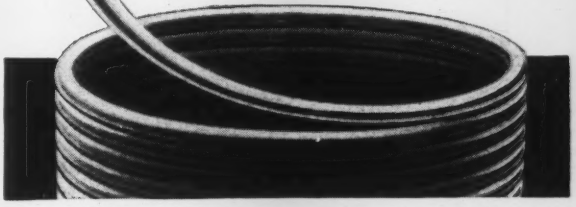
Figure tubing installations *by the Foot...*

You'll find ALUMINUM goes 3 times farther

You *buy* tube by the pound—but you *use* it by the foot, and every pound of it gives you 3 times as many *feet* as other corrosion-resistant metals. It's easy to form and flare, comes in lengths up to 500 feet. Alcoa Aluminum Tubes are worth full consideration in your planning for reduction of instrumentation costs. Aluminum tube fittings are made by nationally known manufacturers.



DUE TO REARMAMENT aluminum is not available for unrestricted industrial use. However, when tubing is used, extensive engineering and planning are often required. This advertisement is intended as an aid to your planning.

For facts on aluminum tubes, write for Alcoa's booklet, "Instrument Lines of Alcoa Aluminum"—illustrated, crammed with facts! Address, ALUMINUM COMPANY OF AMERICA, 838K Gulf Building, Pittsburgh 19, Penna.

ALCOA *Coiled Tubes* ALUMINUM

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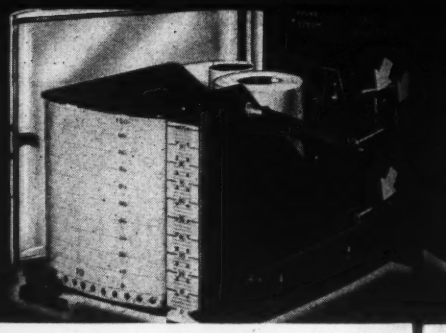
Introducing...

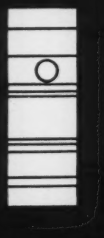
The New TEL-O-SE

8-hour chart visibility without interrupting operations

Built-in adjustable restrictions for pulsating flow



Right side of recorder, illustrating accessibility of zero and fine span adjustments.



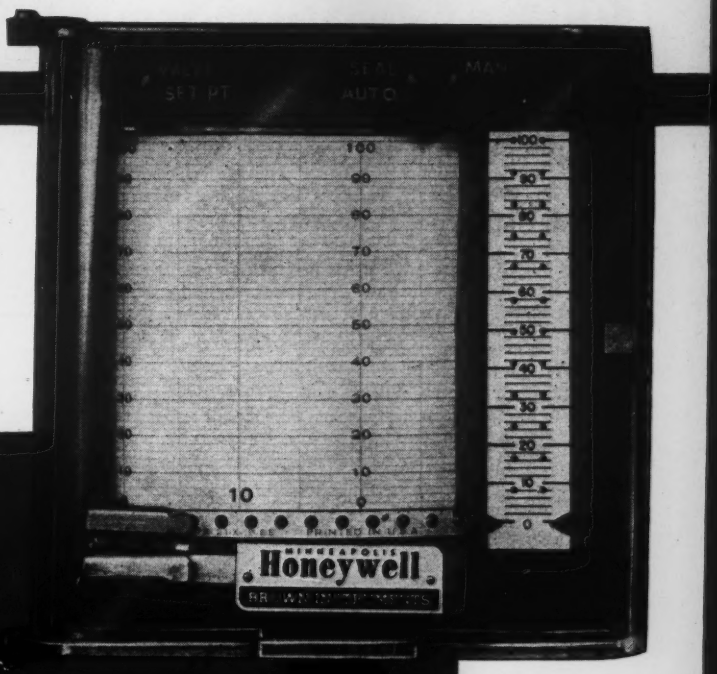
Requires very little panel space... no holes to drill

All adjustments made at front of panel

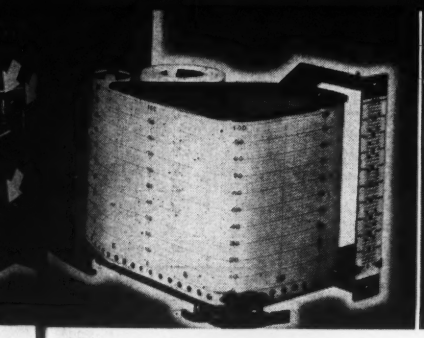
TYPICAL PNEUMATIC SYSTEM FOR FLOW

The Tel-O-Set Recorder pictured in this diagram is one unit of the Foxboro Control Panel, designed and built by an engineered, integrated

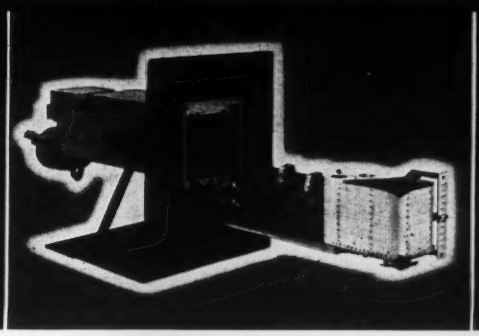
to Process Control



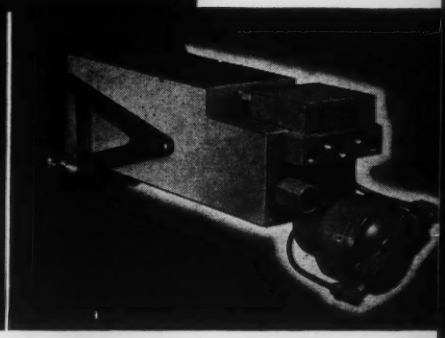
Front view showing transparent plastic cover. Knob at bottom is for adjustment of controller set point when on "automatic," and for regulation of air-to-valve pressure when on "manual." Panel space 5 1/16" high by 5" wide.



Left side of recorder with chassis partially withdrawn and held by safety catch. Note clearly visible 8-hour chart.



Safety catch released, chassis completely withdrawn from case. Air and electrical connections are still intact.



Rear view, showing one of the two detachable side mounting brackets with its single clamping screw.

The new *Tel-O-Set* Recorder, one of an integrated family of instruments, is used for recording such process variables as temperature, pressure, flow and liquid level. It also provides remote set-point adjustment and valve position indication.

Among the many advantages the *Tel-O-Set* Recorder offers are:

- EASE OF MAINTENANCE. Several models are available —all with interchangeable parts.
- ALL ADJUSTMENTS FROM FRONT OF PANEL. Chassis can be partially withdrawn. Zero, coarse and fine span adjustments, and restriction screws are accessible. Unit is in position for easy chart replacement and pen and ink service.
- FULL 8-HOUR CHART visible by sliding chassis only part way while instrument is still in operation.
- PILOT-OPERATED NON-DRIFT PRESSURE REGULATOR.
- BUMPLESS SHIFTING FROM AUTOMATIC TO MANUAL OPERATION.
- BUILT-IN ADJUSTABLE RESTRICTIONS FOR PULSATING FLOW.

For detailed information, write for Specification No. 769.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4482 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
Brown Instruments

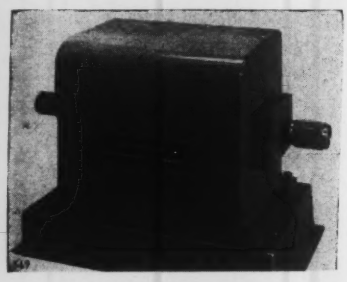
The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, computing, metering and automatic control—in the form of concise technical descriptions.

FOR FURTHER INFORMATION USE THE POSTAGE-FREE ORDER CARD ON PAGE 1245

Induction-type Flowmeter

New "Magnaflow" induction-type flowmeter uses magnetic field at right angles to direction of flow in circular pipe. Potential developed across electrodes is linear function of rate of flow, is independent of viscosity, temperature, pressure levels or fluctuations, and whether or not flow is turbulent or laminar. Smooth-bore sensing tube of same I.D. as system metered may be of Teflon, glass, or stainless steel for acids, food products, or liquid metals, respectively.—*Mittelmann Electronics Div., Century America Corp., 549 W. Washington Blvd., Chicago 6, Ill.*



Mention No. 1001 when filling out card.

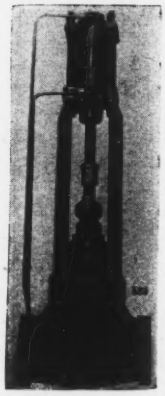
Magnetic Recording Rubber

New magnetic recording rubber consists of magnetic oxide pigmented into neoprene base. Base material has permanent lubricant to eliminate wear of both medium and recording head.—*Div. D-4, The Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio.*

Mention No. 1002 when filling out card.

Valve Actuators

New valve actuators can operate gate valves, plug valves, dampers, diaphragm valves, butterfly valves, and sluice gates. Actuators are maker's cylinders which can work on any fluid medium, and with any pressure available. Can be arranged for on-off or for positioning services.—*Ledeen Mfg. Co., 1602 So. San Pedro St., Los Angeles 15, Calif.*



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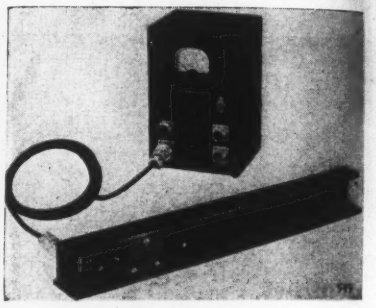
Velocity-stroke Indicator

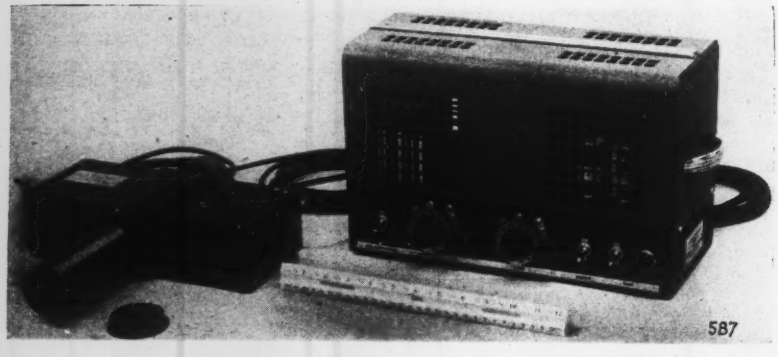
New velocity-stroke indicator permits direct measurement of instantaneous velocity or position of high-speed mechanisms having large linear movement of either periodic or non-recurring type. Also measures instantaneous velocity versus stroke position. Oscillograph is used in conjunction with indicator for presentation or recording of data. Indicator consists of slide-wire assembly and control box. Slide-wire assembly has straight-wire resistance element. Differentiating network develops voltage proportional to instantaneous velocity of slider. Control box houses differentiating network, voltage indicating and adjusting circuit, and calibration circuit.—*Aero Electronics Co., 1902 W. Division St., Chicago 22, Ill.*



Mention No. 1005 when filling out card.

Radiation-pyrometer-type Wide-range Thermometer

New "H-G-B Infrared Pyrometer" has for its primary element a high-sensitivity bolometer on which a parabolic mirror focuses radiant flux from an object under measurement; also a chopper whereby bolometer output is converted to a.c. for ease of amplification. Temperature range is said to be "from subzero to red heat." Response time is approx. 0.01 sec. Minimum measurable area (as in study of hot spots or small objects) is 0.5 in. x 0.125 in. Equipment operates from usual 115-v. 60-cycle supply; consists of 8½-lb. "detecting head" (left), final amplifier (right), and user's choice of indicator, recorder, oscilloscope, controller, accessories, etc.—*Hanson-Gorrill-Brian, Inc., 1 Continental Hill, Glen Cove, N. Y.*



Mention No. 1004 when filling out card.

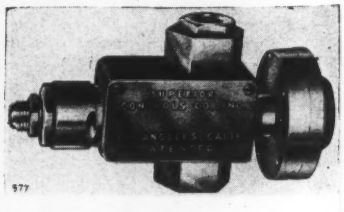
Panel Instrument

New "Model 1329" is 2.5 in. d-c. and a-c. rectifier-type panel instrument. Scale length is 3.7 in. over 250 deg. deflection. Six mounting holes permit tight sealing to panel. Instrument is magnetically shielded; has zero corrector. Accuracy rating on d-c. is 2 percent.—*Weston Electrical Instrument Corp., 641 Frelinghuysen Ave., Newark 5, N. J.*

Mention No. 1006 when filling out card.

Reverse-action Regulator

New "Type L-25R" reverse-action regulator for oil, kerosene, and liquid fuels opens with steam pressure and remains open until steam pressure drops below set point. Operates at any desired boiler pressure. Needle-



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Constant Millivolt Characteristics

over a wide range of ambient temperatures are assured by a high manganin to copper ratio plus a series negative temperature coefficient resistor. Automatic cold end compensator adjusts for changes in ambient temperature during a test.

Low Contact Resistance

The selector switch is of heavy duty construction designed for a low and constant value of contact resistance . . . of prime importance when high accuracy is required. Multi-point switch is housed in separate compartment in the case which also contains a high grade mercury in glass thermometer.

Direct Reading

Just turn the switch to the desired circuit and read the temperature directly—no balancing operations or conversion charts. Large 6" scale face is easily and quickly read. Knife edge pointer and mirror eliminate parallax errors. Single or double scale ranges available. Illinois Testing Laboratories, Inc., Rm. 518, 420 N. La Salle St., Chicago 10, Illinois

Overlapping Contacts

When switching from one circuit to another, the new circuit is made before the old is broken . . . the meter circuit is never opened during switching, thus eliminating the possibility of damage due to excessive and wild pointer swing.

portable multi-circuit Pyrometer

Type 1200 precision-built, self-contained, portable that gives instant, accurate readings of temperatures at a number of points in rapid succession. Available with 8 or 17 circuits. Scale ranges from 0-300° to 0-3000° F. and their centigrade equivalents.

Type 1000 Portable Resistance Thermometer with 8 circuit switch for low temperature service. Available in a variety of ranges between —100° F. and +400° F. A span as small as 50° F. can be supplied.

Combining portability with precision laboratory performance, Alnor Portable Multi-Circuit Pyrometers make possible accurate temperature measurement at a multiplicity of points in rapid succession. Type 1200 Pyrometer is particularly valuable in reading temperature rise of various portions of an electrically operated device or repetitive tests on a production run of closely controlled units.

Featuring modern design and rugged construction throughout, Alnor Pyrometers have precision-built double air gap movements of exceptionally high internal resistance . . . famous Alnico magnets . . . the finest in sapphire bearings and hardened steel pivots. Ask your Alnor representative for complete details and prices on these accurate and reliable instruments.

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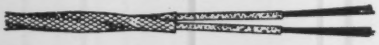
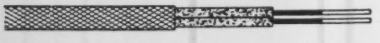


CHROMEL-ALUMEL, Cat. No. 1231(3-A), 14 ga., STRANDED-DUPLEX, each wire felted asbestos, Asbestos-yarn braid overall.

FOR PLATINUM THERMOCOUPLES, Cat. No. 1225, 16 ga., STRANDED-DUPLEX, each wire felted asbestos, Asbestos-yarn braid overall.



CHROMEL-ALUMEL, Cat. No. 1234, 14 ga., SOLID-DUPLEX, each wire enamel, felted asbestos, Asbestos-yarn braid overall.

IRON-CONSTANTAN, Cat. No. 1236-C, 14 ga., STRANDED-DUPLEX, each wire felted asbestos, Asbestos-yarn braid overall.

COPPER-CONSTANTAN, Cat. No. 1235-A, 14 ga., SOLID-DUPLEX, each wire cotton, rubber, weatherproof braid, lead sheath overall.

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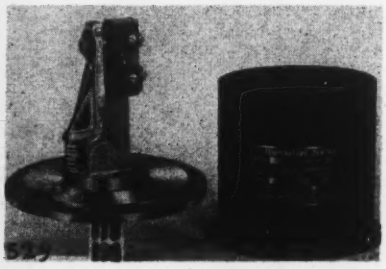
NEW INSTRUMENTS

valve action produces modulated flow for constant pressure. Precision machined of brass or stainless steel. Has standard 1/8-in. orifice. Inlet pipe size is 1/2 in.; outlet 1/4 in.—*Superior Controls Co., Inc.*, 1835 *S. Bonnie Brae, Los Angeles 6, Calif.*

Mention No. 1007 when filling out card.

Electrical-switch Type Temperature Controller

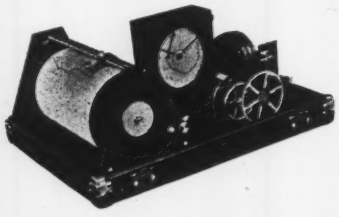
New "Model V-1C Water, Vapor and Dust Tight Temperature Control" has a ribbed cast-aluminum base tapped for 0.5-in iron pipe size electrical conduit or pipe. It is interchangeable with maker's other instrument heads and can be supplied for any temperature from minus 200 F. to 1400 F. with standard tubes and up to 1600 to 1800 F. with special tubes. It incorporates s-p.d-t. Micro Switches, either normally-open or normally closed. Manual reset switches are also available—*Burling Instrument Co., 5 Vose Ave., South Orange, N. J.*



Mention No. 1008 when filling out card.

Recording Microbarograph

New recording microbarograph uses null principle; records pressures over range of plus or minus 1.00 in. mercury and can be used at any elevation from sea level to 10,000 feet by means of reset. Power in actuating and recording mechanism is supplied by two sealed instrument clocks. 24-hour chart is graduated in intervals of 0.005 in. merc.; curve is drawn by metallic point; no ink is used. Weight, 30 lbs.; dimensions, 11 x 16 x 20 in.—*American Paulin System, 1847 S. Flower St., Los Angeles 15, Calif.*



Mention No. 1009 when filling out card.

Oil-burner Controller

New combination of maker's "V-5" stainless-steel solenoid valve with a time delay device is said to raise efficiency and cut out soot-causing smoke in domestic oil burners by preventing oil flow until oil pressure and fan speed reach their peak efficiency. At this point, valve opens and oil is sprayed suddenly into fire box already filled with swirling air. Result is proper combustion from beginning.—*Skinner Electric Valve Div., Skinner Chuck Co., Belden Avenue, Norwalk, Conn.*

Mention No. 1010 when filling out card.

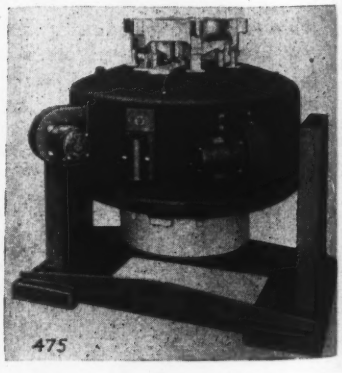
Solenoid Hydraulic Valve

New pilot-operated model of "Hydr-OILic" 5000-psi. valve is said to overcome problem of spool-sticking common to 4-way solenoid valves in high-pressure hydraulic circuits used for long cycling operations. It utilizes system pressures to move the spool, solenoids being used only to operate small internal pilot valves. New units are available in ¾ in. and 1½ in. sizes, in both single- and double-solenoid types, with provision for either external or internal pilot connections. Eight types of spools provide for eight different porting combinations.—*The Denison Engineering Co., 1160 Dublin Road, Columbus 16, Ohio.*

Mention No. 1011 when filling out card.

Vibration Exciter

New "Model C-25" vibration exciter meets specification MIL-E-5272 and 41065B on vibration testing; develops 2500 lbs. force and is capable of 15-G accelerations under 100-lb. table load; features continuous control of both frequency and force, with electrical interlocks to prevent improper operation of the equipment. Weight, approx. 4500 lbs.; table diam., 20 in. No special

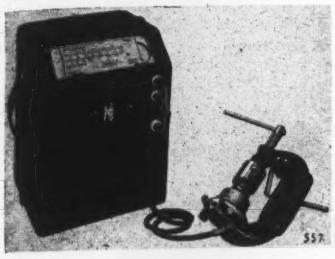


mounting foundations required. Control panel is available with instrument to read vibration directly in terms of its acceleration, velocity and displacement.—*The MB Mfg Co., Inc.*, 1060 *State St., New Haven* 11, *Conn.*

Mention No. 1012 when filling out card.

Moisture Meter

New British-made battery-operated "Type TF 933" moisture meter measures moisture content from below air-dry to near saturation. Accuracy is about 0.2 percent m.c. under controlled



conditions. Three calibrated scales are for wheat, flour, tobacco, etc. Uses bridge circuit. Pressure is applied to specimen under test.—*Marconi Instruments Ltd.*, 23 *Beaver St., New York* 4, *N. Y.*

Mention No. 1013 when filling out card.

Electrophoresis Apparatus

New "Model 38" Tiselius Electrophoresis Apparatus makes possible ready visualization of complete electrophoretic patterns by means of a cylindrical lens. This lens plus diagonal exit slit adapt new "Model 38" to Philpot-Svensson system. Both lens and slit assembly may be brought in or out of beam by external controls, enabling user to resort to conventional Longsworth scanning method. Cylindrical lens may be added to present "Model 38's," if so desired.—*The Perkin-Elmer Corp., Norwalk, Conn.*

Mention No. 1014 when filling out card.

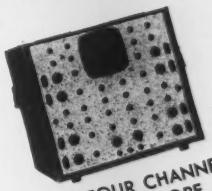
Level Switch

"New Model AJ-1 Tektor" is said to make possible level control of practically all liquids and solids. Liquids may be of high or low viscosity and may have electrical conducting or insulat-

...FOR CRITICAL ANALYSES

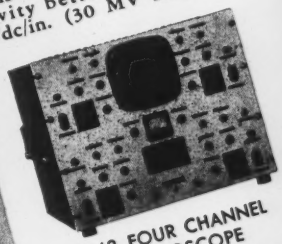
H-21 DUAL CHANNEL OSCILLOSCOPE

Indicates 2 independent signals simultaneously. Sensitivity better than 0.085 Vdc/in. (30 MV rms/in.)



H-45 FOUR CHANNEL OSCILLOSCOPE

Offers choice of any combination of high sensitivity dc amplifiers or wide band ac amplifiers.



H-43 FOUR CHANNEL OSCILLOSCOPE

Designed for strip-film recording of up to 4 variables on a single 5" tube. Readily portable.

H-22 UNIVERSAL DUAL CHANNEL OSCILLOSCOPE

Plug-in ac or dc amplifiers. Two independent channels on a single tube register phenomena from dc to 1 megacycle.

ETC

Multi-Channel Oscilloscopes

H-81 EIGHT CHANNEL OSCILLOSCOPE

A unique design originally developed for film strip recording of seismographic phenomena. Frequency response 20 to 150,000 cps. A DC model with sensitivity of 2 MV dc/in. also available.

As specialists in multi-channel 'scopes, ETC offers a broad line for critical testing, production and research needs. In addition to standard types incorporating 2, 4, and 5 wave forms on a single tube, many special designs and adaptations are regularly produced for specific uses. Full details on any type will gladly be sent on request.

MULTI-GUN CATHODE TUBES

The answer to problems involving registration of a multiplicity of transients on a single screen. 2-, 4-, 6-, 8- and 10-gun types. Also a complete line of standard 5" cathode ray tubes.

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DC-AC
CHOPPER
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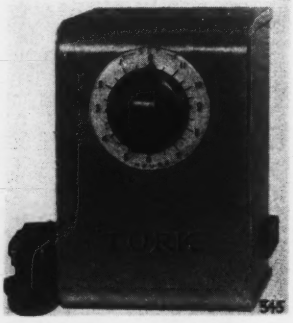
Meets AN Specifications
also 60 cycles
Single pole and double pole
Make-before-break contacts
Contacts in air or in liquid
These Choppers convert low level DC into pulsating DC or AC so that servo-mechanism error voltages and the output of thermocouples and strain gauges, may be amplified by means of an AC rather than a DC amplifier.
They are hermetically sealed, precision vibrators having special features which contribute to long life and low noise level.
WRITE FOR THESE CATALOGS...
#280 10-500 cycles
#246A 60 cycles
STEVENS ARNOLD INCORPORATED

ing properties. No electrical contact is necessary with material under control. Electrode cable consists of a probe, 4 in. to 6 in. long, 0.25 in. to 0.375 in. diam., inserted into container at level at which control is required. Operating differential of 0.031 in. up to 0.375 in. may be obtained. Probe may be insulated or not, depending on application. —*Fielden Instrument Corp., 2920 N. Fourth Street, Philadelphia 33, Pa.*

Mention No. 1015 when filling out card.

Interval Timers

New revised line of "Single-Set Tork Timers" may be had for either permanent installation or for portable

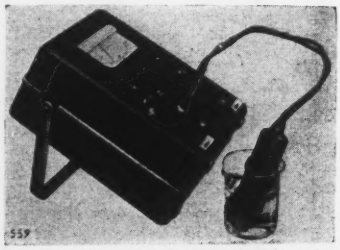


use with cord and plug. Portable plug-in models are rated 6 or 15 amps. S-p.s-t. normally-open a-c. switch is timed and powered by a self-starting synchronous Telechron motor. Contacts are of either 20-amp. or 30-amp. capacity.—*Tork Clock Co., Mount Vernon, N. Y.*

Mention No. 1016 when filling out card.

pH Meter

New battery-operated portable "Type TF 889" pH meter has range from 1 to 11 pH with discrimination of 0.05 pH. Uses electrometer tube in bridge

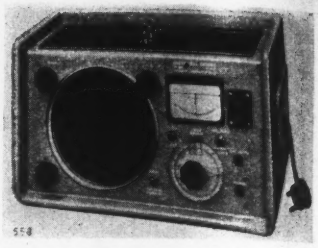


circuit, manual temperature compensator (10-50 C.), calomel reference electrode, and "Marconi" glass electrode.—*Marconi Instruments Ltd., 23 Beaver St., New York, N. Y.*

Mention No. 1017 when filling out card.

Universal Bridge

New British-made "Type TF 868" bridge measures resistance, capacitance, inductance, Q, and power factor. Has following ranges: L—1 uH. to 100 H.; C—1 uuf. to 100 uf.; resistance—0.1 ohm to 10 megohms; Q—0.1 to 10; tan

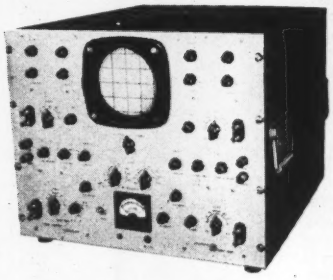


δ—0.001 to 0.1; power factor—0.001 to 0.995. Accuracy for L, C, and R is ±1 percent, except at extremes; accuracy for tan δ is ±10 percent. Uses 1000-cps. oscillator for measurement of L and C. —*Marconi Instruments Ltd., 23 Beaver St., New York 4, N. Y.*

Mention No. 1018 when filling out card.

Dual-channel Oscilloscope

New "Model H-23" dual-channel oscilloscope permits "for the first time a flat frequency response from d.c. to 1 Mc." With two independent channels working into a single two-gun cathode ray tube. Vertical-deflection amplifiers

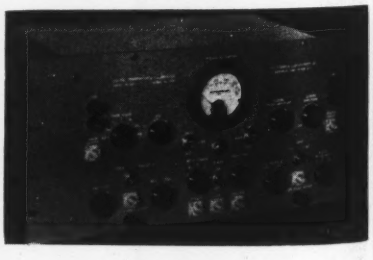


have capacitive and conductive input attenuators, allowing operation as either a-c. or d-c. coupled amplifiers. Each channel has independent sweep generator designed for either single-sweep or recurrent operation. Both channels may be switched to one sweep. Other features: independent control of intensity, intensity-modulation, focus, and positioning of each electron beam. —*Electronic Tube Corp., Philadelphia 18, Pa.*

Mention No. 1019 when filling out card.

Pulse Generator and Calibrator

New "Model PC-100 Pulse Generator and Calibrator," for general use with triggered oscilloscopes and as a source of pulses for triggering other equipment, produces two short-duration rectangular pulses whose amplitudes and polarities can be independently controlled. Repetition frequency, and time-



interval between, are also adjustable. Unit can be synchronized from an external source; or may be operated self-synchronous to generate a pulse for synchronizing other equipment.—*Dep't I, Teletronics Laboratory, Inc., 352 Maple Ave., Westbury, L. I., N. Y.*

Mention No. 1020 when filling out card.

Time-delay Generator

New "Model A-4 Time-delay Generator" produces variable delays from 10 microseconds to 10 seconds in five ranges. Blocking oscillator and single-shot vibrator output waveforms are provided. Linearity is 0.3 percent, accuracy is 0.1 percent (after calibration) and 1 percent (long term). Blocking oscillator pulse is 0.5 microsecond wide with rise time of 0.1 microsecond. Multivibrator output pulse is presented through cathode follower; width is function of delay range in use.—*Rutherford Electronics Co., 3707 S. Robertson Blvd., Culver City, Calif.*

Mention No. 1021 when filling out card.

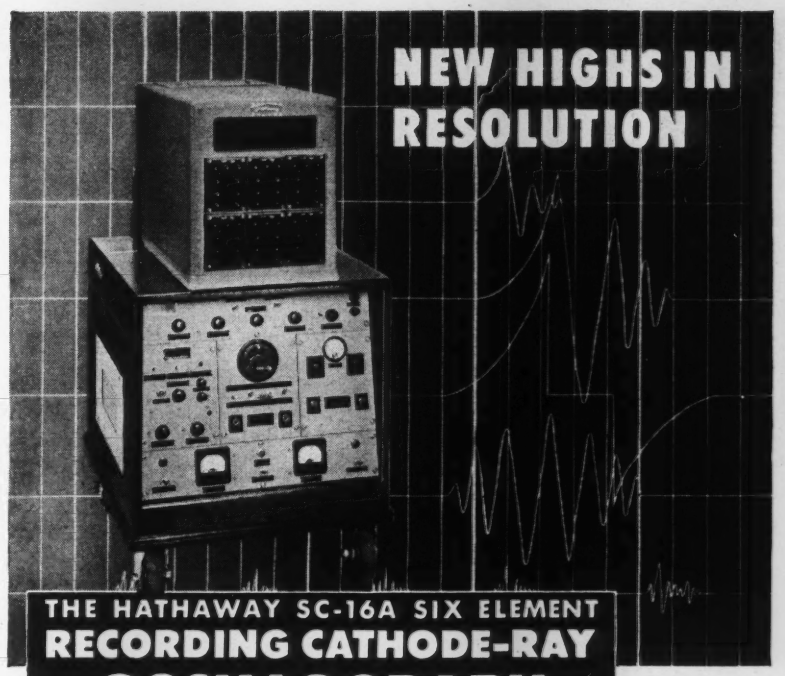
Volt-ohmmeter

New "WV-77A Junior VoltOhmyst" measures a-c. volts, d-c. volts, and resistance. High-impedance diode tube is signal rectifier. Uses electronic bridge circuit, 200-microampere movement, and carbon-film multiplier resistors. Slip-on probe eliminates separate cables. Measures d.c. from 0.05 v. to 1200 v. in 5 ranges; a.c. from 0.1 v. to 1200 v. rms. in 5 ranges; resistance from 0.2 ohm to one billion ohms in 5 ranges. High input resistance on all ranges. Available from distributors.—*RCA Tube Dep't, Radio Corp. of America, Harrison, N. J.*

Mention No. 1022 when filling out card.

Derivative-integral Filter

New "Model 340A" derivative-integral servo-design filter for use in servomechanism design is variable from 0.01 to 100 cps. Other features: direct-reading frequency and attenuation dials,



THE HATHAWAY SC-16A SIX ELEMENT
RECORDING CATHODE-RAY
OSCILLOGRAPH

NEW HIGHS IN RESOLUTION are obtained by this new oscillograph because of its unusually HIGH FREQUENCY RESPONSE and HIGH CHART SPEED...designed for recording fast transients and continuous phenomena.

FREQUENCY RESPONSE 0 to 200,000 cycles per second
RECORDS up to 1000 ft. long at speeds up to 600 inches per second
RECORDS up to 10 ft. long at speeds up to 6000 inches per second
WRITING SPEED as high as 5,000,000 inches per second

Note these additional unusual features.

- SIX ELEMENTS with convenient interchangeable lens stages for 1, 2, 3, or 6 traces on full width of chart.
- INTERCHANGEABLE RECORD MAGAZINES for CONTINUOUS RECORDING on strip chart, either 6 inches or 35mm in width up to 1000 feet in length, DRUM RECORDING for short, high-speed records, and STATIONARY CHART for very short transients.
- PRECISION TIMING EQUIPMENT, tuning fork controlled, for 1-millisecond or 10-millisecond time lines.
- Crystal-controlled Z-AXIS MODULATION for 1/10 millisecond time marks.
- QUICK-CHANGE TRANSMISSION for instantaneous selection of 16 record speeds over a range of 120 to 1.
- AUTOMATIC INTENSITY CONTROL.
- CONTINUOUS SWEEP OSCILLATOR which permits viewing as well as recording.
- Single-pulse LINEAR OSCILLATOR for recording transients on stationary film. The record can initiate the transient to be recorded, or the transient can initiate the record.

Each recording element is a complete unit, fully housed, which can be instantly inserted or removed. Recording element contains high-intensity cathode-ray tube, and both AC and DC amplifiers. Control panel is located on outside end.

FOR FURTHER INFORMATION, WRITE FOR BULLETIN 2 G-1-H

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NEW INSTRUMENTS

single-scale logarithmic dials, and attenuation ratio adjustable from 2 to 50. Represents a compensating function which approximates either proportional-plus-derivative or proportional-plus-integral correction.—*Krohn-Hite Instrument Co.*, 580 *Massachusetts Ave., Cambridge* 39, *Mass.*

Mention No. 1023 when filling out card.

VT Millivoltmeter

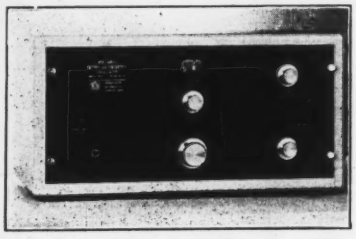
New British-made "Type TF 899" VT millivoltmeter has ranges of 150 and 500 mv., and 2 v. Response is

from 50 cps. to 100 Mc. (± 2 db). Consists of bridge circuit with grid-leak detector-amplifier as one arm.—*Marconi Instruments Ltd.*, 23 *Beaver St., New York* 4, *N. Y.*

Mention No. 1024 when filling out card.

Low-frequency Oscillator

New improved "Model 410-A" ultra-low frequency oscillator has frequency range of 0.02-20,000 cps. Other features include both sine-wave and square-wave output, amplitude constancy, low drift, and low distortion.—*Krohn-Hite Instrument Co.*, 580 *Massachusetts Ave., Cambridge* 39, *Mass.*



Mention No. 1025 when filling out card.

High-voltage Power Supplies

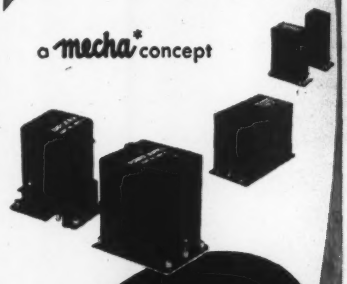
New units added to maker's line of high-voltage d-c. r-f. type power supplies are available covering both variable and fixed voltage outputs from 1 kv. to 60 kv. and current ranges from 50 microamps to 2 milliamps. Both self-regulating and electronically-stabilized d-c. power supplies are available. New models are capable of operating several of the 5WP4, 5TP4 or Flying Spot tubes at the same time.—*Inductograph Products Inc.*, 236 *W. 55th St., New York* 19, *N. Y.*

Mention No. 1026 when filling out card.

PACKAGED Functional Components Electronic, Electro-mechanical

simplified electronic synthesis

a mecha* concept



Servomechanisms, Inc., pioneers in standardized, packaged, plug-in electronic and electro-mechanical functional units for control systems. Each unit is a "building block" or component for control device synthesis. Each unit is a specific function, easily plugged in or out for checking and service. A system composed of several packaged functions fulfills today's need for—

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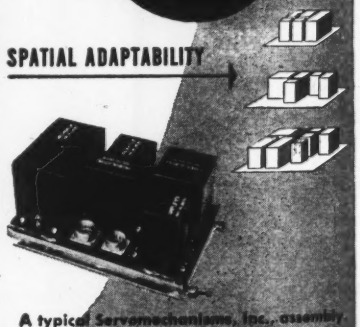
- Instant Maintainability
- Training Simplicity
- Ease of Assembly

SPATIAL ADAPTABILITY



A typical Servomechanisms, Inc., assembly

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POST & STEWART AVENUES, WESTBURY, N.Y.

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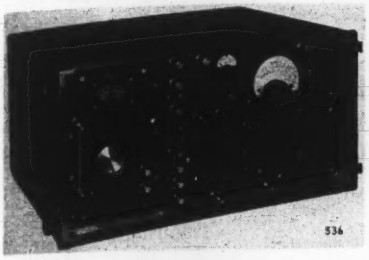
Noise and Field-intensity Meter

New "Model NF-105" noise and field-intensity meter covers frequency range from 20 to 400 Mc. Operates on 115 volts, 50 to 400 cps., or, by using an



inverter, on 12 or 24 volt batteries. Bandwidth is 70 kc. from 20 to 200 Mc. and 200 kc. from 200 to 400 Mc. Voltage range as r-f. voltmeter is 1 to 100,000 microvolts. VSWR is below 1.2 to 1. Sine-wave generator and impulse generator used as calibrators. Logarithmic indicating meter calibrated in both db. and microvolts.—*Empire Devices, Inc.*, 38-25 *Bell Boulevard, Bayside, N. Y.*

Mention No. 1027 when filling out card.

Low-frequency Filter

New improved "Model 330-A" ultra-low frequency band-pass filter for use in vibration and other studies is variable from 0.02 to 2,000 cps. Other features: adjustable center frequency, adjustable band width, unity pass-band gain, 24 db/octave slope, corner frequency peaking, and low internal noise.—*Krohn-Hite Instrument Co.*, 580 *Massachusetts Ave., Cambridge* 39, *Mass.*

Mention No. 1028 when filling out card.

Low-frequency Filter

New improved "Model 350-A" ultra-low frequency rejection filter is variable from 0.02 to 2,000 cps. Other features: Adjustable center frequency, adjustable band width, band rejection or sharp null filtering, 24 db/octave slope, corner frequency peaking, and low internal noise.—*Krohn-Hite Instrument Co.*, 580 *Massachusetts Ave., Cambridge* 39, *Mass.*

Mention No. 1029 when filling out card.

Grid-dip Meter

New improved "Type GDO-1" grid-dip meter covers frequency range from 1.5 to 300 Mc. with 7 plug-in coil ranges. Unit features probe-type oscillator, built-in coil-storage compartment, 4.5-in. microammeter, internal

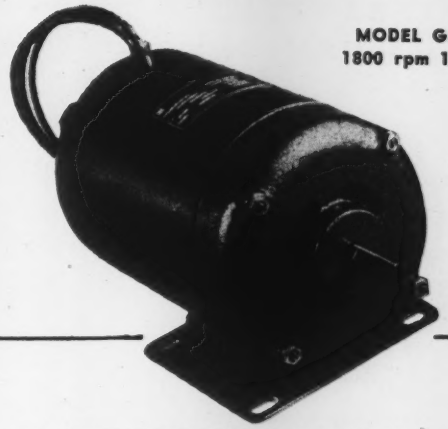
Stabilized

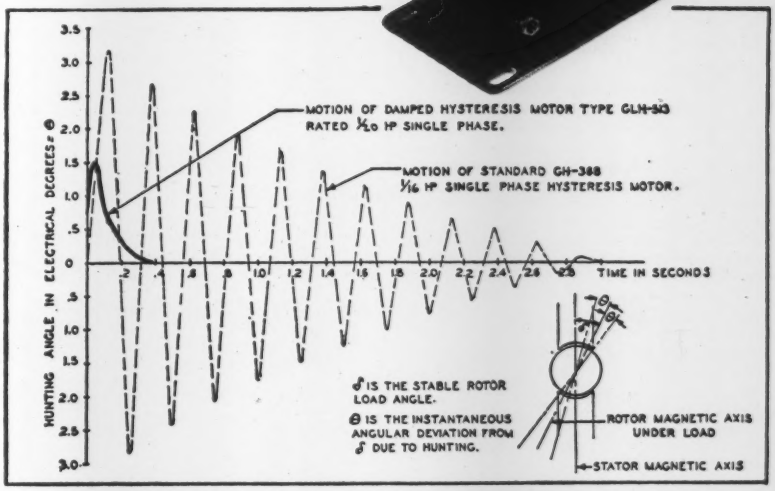
•HYSTERESIS MOTOR

NON-HUNTING

FULLY-DAMPED MOTION FOR LARGE INERTIA LOADS

MODEL GL 513
1800 rpm 1/20 hp




MOTION OF DAMPED HYSTERESIS MOTOR TYPE GLH-513 RATED 1/20 HP SINGLE PHASE.
MOTION OF STANDARD GH-388 1/16 HP SINGLE PHASE HYSTERESIS MOTOR.
HUNTING ANGLE IN ELECTRICAL DEGREES = θ
TIME IN SECONDS
δ IS THE STABLE ROTOR LOAD ANGLE.
θ IS THE INSTANTANEOUS ANGULAR DEVIATION FROM δ DUE TO HUNTING.
ROTOR MAGNETIC AXIS UNDER LOAD
STATOR MAGNETIC AXIS

Approximate motion curves for standard and damped hysteresis with load inertia of 180 ounce—(inches)² by weight, rotating 1800 rpm.

THE new Model GL 513 Elinco motor is excellent for all sound and optical work, for goniometer drives, and all other applications where a high degree of motional stability is essential. It permits higher basic motor speeds for a given load inertia without increase in flutter . . . allowing greater power output for fixed motor size.

The curves compare a standard 1/16 hp hysteresis motor with the new GL 513: note that the non-hunting motor not only radically reduces the **duration** of any oscillation, but also cuts the **magnitude** of the initial swing about 50%. Furthermore, whereas the standard motor, after one oscillation, damps out a connected load of only 9 oz.in.² by weight, the GL 513 shows a value of 180 oz.in.²

Model GL 513 is currently available for reasonable future delivery; other stabilized units, with other speed and voltage ratings as well as multiple-speed units, are under development.

ELINCO

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NEW ONE-PACKAGE CONTROL SYSTEM

for DIFFERENTIAL TRANSFORMERS or STRAIN GAGES at the Flip of a Switch

DYNA-MYKE

The Dyna-Myke Model 129-B is a precision, high speed, dynamic micrometer using linear differential transformers as the sensing element. It measures and provides for recording such phenomena as force, torque, strain, vibration, acceleration, temperature, pressure, thickness, surface finish, etc., with a linear frequency response of DC to 1000 cps. Direct displacements are measured in five ranges from ±.1 inch to ±10 micro inches. On standard magnetic recorders a sensitivity of 1 micro inch per millimeter is available. A toggle switch converts the Dyna-Myke to a high frequency, high sensitivity strain gage indicator. The output is used to drive any type of magnetic, null balance or galvanometer recorder—or the DC or modulated carrier may be viewed on an Oscilloscope. Selsyn motors may be driven for remote indication or control. Request Technical Bulletin 129-B for full details.

DYNA-METER

The Dyna-Meter Model 144, when used with the Dyna-Myke, indicates by neon lights the peak amplitude of transients as fast as 1 millisecond. This indication may be instantaneous or a memory feature may be used to maintain the reading until reset. Built-in power relays provide on-or-off control to any plus or minus limits established by the Dyna-Myke. The combination of the Dyna-Myke and the Dyna-Meter offers many applications to industrial processes resulting in the elimination of scrap *at the source*. Uses in connection with machine tool operations are particularly impressive. Request Dyna-Meter Technical Bulletin 144.

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8064 Wheeler St., Detroit 10, Mich.

NEW INSTRUMENTS

modulation, and a calibration accuracy of 0.02 percent measured at 30 Mc.—*Sylvan Electronic Laboratories, Inc., Broadalbin, N. Y.*

Mention No. 1030 when filling out card.

Insulation Tester

New "Vibrotest Model 264" is insulation-resistance tester with testing range

from 0-100 megohms at 500 volts d.c.; plus a low-range 0-10,000 ohm scale. Weight with batteries, 18 pounds.—*Associated Research, Inc., 3766 W. Belmont Ave., Chicago 18, Ill.*

Mention No. 1031 when filling out card.

Height Indicator

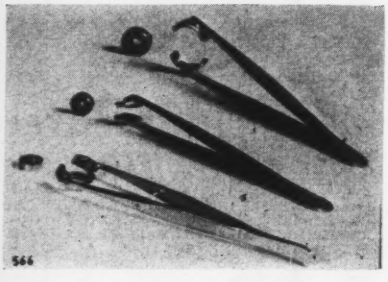
New "Electronic Height Indicator" is for toolroom use and inspection where highly accurate measurement is desired from a surface plate reference. Electronic gage head has amplification

of 1000 or 2000. Smallest graduation is 0.0001 in. Scale is plus and minus 0.0015 in. and 0.003 in. Vertical capacity is 26 in. Pickup head can be rotated through 360 deg.—*Sheffield Corp., Dayton 1, Ohio.*

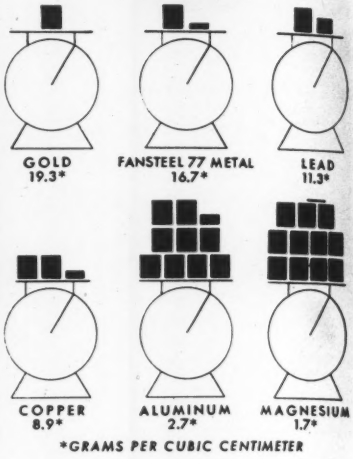
Mention No. 1032 when filling out card.

Ball-bearing Tools

New tools for handling instrument ball bearings are special tweezers. Furnished in two models—one for grip-



For High Density In Small Space



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Fansteel 77 Metal

Strong and machinable, with a density almost as high as gold and closely approaching that of pure tungsten, Fansteel 77 Metal is the practical, economical high density material.

Useful for rotors, flywheels, governors, balance weights where maximum weight is necessary in minimum space. Also useful for radiation shields against X-ray and gamma radiation.

Available forms include finished or semi-finished parts, bar, rod, rings, disks, slabs or special shapes. Fansteel Metallurgical Corporation, North Chicago, Illinois, U. S. A.

Ask for Bulletins:

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- ☐ Fansteel Siliconized Molybdenum
- ☐ Fansteel Tungsten and Molybdenum
- ☐ Fansteel Tantalum

12501-A

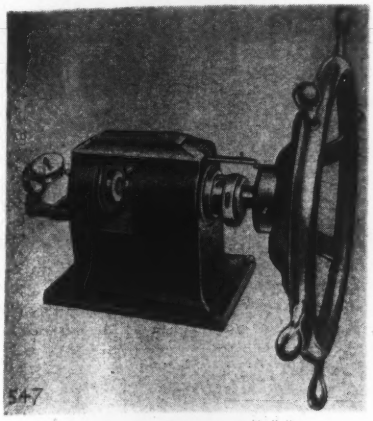
Fansteel
SPECIAL PRODUCTS
by Controlled Metallurgy

ping bearing by inside race; other for outer race.—*The Baker Co., Maplewood, Maine.*

Mention No. 1033 when filling out card.

Sheet Metal Tester

New (to U. S.) "Alexander's Sheet Metal Tester" is a British instrument for making Erichsen Test, which determines actual "workability" of fer-

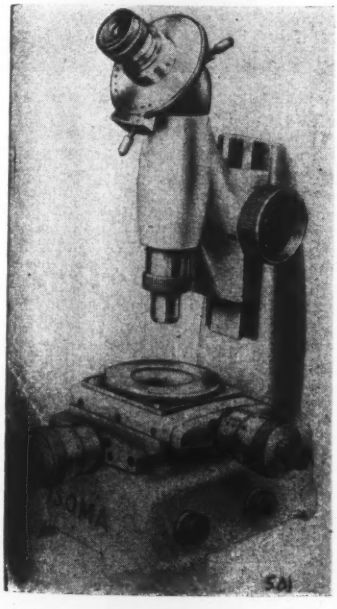


rous, non ferrous and fine metal sheets and strips to point of fracture. Tester will handle material up to 5/64 in. thick. Test method provides an effective means for material controls between supliers and users: specifications can be established by agreeing on certain minimum "Standard Values."—*J. Arthur Deakin & Son, 150-28 Hillside Ave., Jamaica 2, N. Y.*

Mention No. 1034 when filling out card.

Toolmaker's Microscopes

New "Isoma" toolmaker's microscopes have interchangeable objectives for 20X, 30X, 50X or 100X magnification; a 360-deg. angle measuring device graduated and numbered every 10 minutes; adjustable illumination for top and underneath lighting of work-



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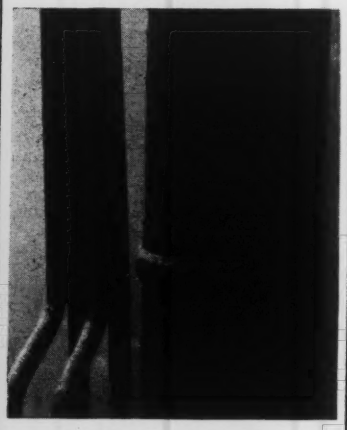

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piece, and support and holding accessories. Micrometer spindles are calibrated in 0.005 and 0.00005 in.—*Cosa Corp., 405 Lexington Ave., New York 17, N. Y.*

Mention No. 1035 when filling out card.

Laboratory Microscopes

New line of laboratory microscopes, called "Dynoptic Labroscopes," feature ball bearings and rollers throughout focusing system, low-position fine adjustment and a mechanical stage with low controls that enable operator, after setting coarse adjustment, to rest his

hand on table and manipulate the other controls in a comfortably relaxed position. Substage equipment, in addition to that formerly available, includes a variable focus condenser in a tubular mount which does not require a rack-and-pinion substage; also a substage illuminator which can be used integrally with new "Labroscope" in place of mirror or separately. Optical equipment includes a new, longer working distance and non-divisible 10× achromatic objective.—*Bausch & Lomb Optical Co., 635 St. Paul St., Rochester 2, N. Y.*

Mention No. 1036 when filling out card.

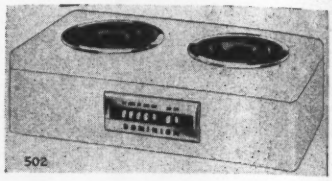
Laboratory Oven

New "Model HT" portable electric oven is said to feature extremely uniform temperature throughout. Construction permits nesting one oven on top of another. Temperature range is 100 to 800 F. Thermostat, outside reading thermometer, pilot light, drip pan, and lower shelf are standard equipment. Inside dimensions are 22 in. wide x 18 in. deep x 16 in. high.—*Grieve-Hendry Co., Inc., 1101 N. Paulina St., Chicago 22, Ill.*

Mention No. 1037 when filling out card.

Laboratory Hot-plate

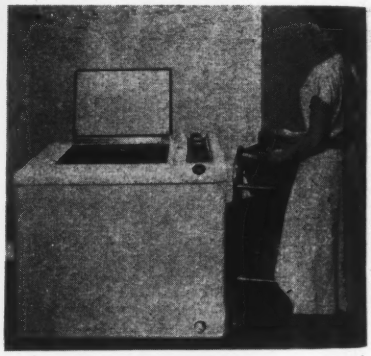
New "Model 1429" two-burner electric hot-plate has five-heat push-button control, easy-to-clean "Monotube" heating elements.—*Dominion Electric Corp., Mansfield, Ohio.*



Mention No. 1038 when filling out card.

Laboratory Glassware Washer

New Laboratory Glassware Washer takes six large basketfuls of labware at once; delivers them thoroughly washed and rinsed, chemically clean, in a fraction of time required by conventional "dishwashing." All operation controls are on one panel in easy reach of operator. Plugged drains are readily cleaned from front of the cabinet. Glassware accidentally dropped into washer and broken can be quickly removed via bottom of tank. Two models: (1) steam-heated, operating on either 115 or 230 volt a.c.; (2) electrical, operating on 230 volt a.c. Both have connections for hot and cold water, and drains. In addition, steam model makes use of 5- to 30-psi. steam as a temperature control and drying aid.—*Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Penna.*



Mention No. 1039 when filling out card.

Demineralizer

New "Mono-Bed Demineralizer" uses deionizing technique. Cation and strong-base anion exchangers are mixed in one tank, thus providing equivalent of "multiple-bed systems." Raw water passes through "Mono-Bed" column once; comes out with

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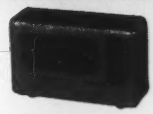

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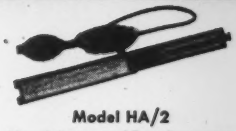

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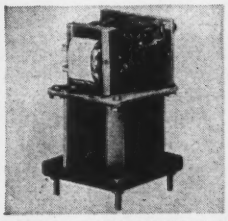

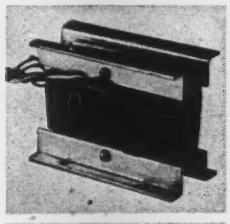

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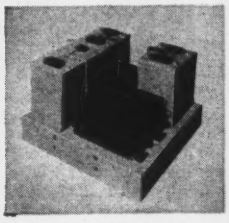

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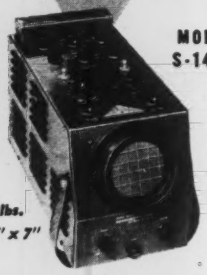

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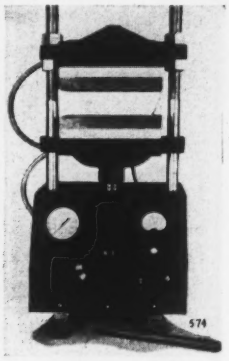
NEW INSTRUMENTS

mineral content of virtually zero (resistances as high as 20,000,000 ohms per centimeter).—*Penfield Mfg. Co., Inc., 19 High School Ave., Meriden, Conn.*

Mention No. 1040 when filling out card.

Laboratory Press

New "Model 12-10" hydraulic laboratory press provides total force of 24,000 lbs. Gage indicates pounds per square inch on ram. Stroke is 6 in.; maximum opening, 10 in. Heating

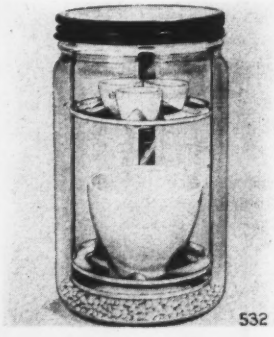


platens may be readily removed. Bimetallic temperature regulator and relayed load method is used. Thermocouples measure platen temperature.—*Wabash Metal Products Co., 1569 Morris St., Wabash, Ind.*

Mention No. 1041 when filling out card.

Desiccator

New "Bethlehem Dri-Jar" is a laboratory desiccator adaptable to a number and variety of samples; may be used for storage of either hot or cold crucibles in a size range from No.

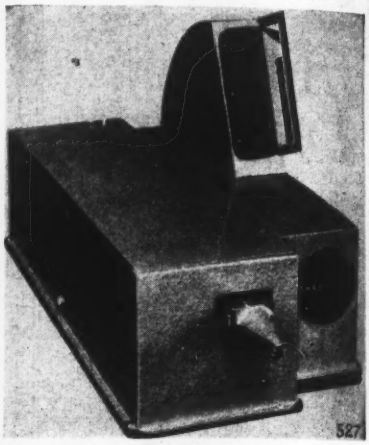


000 to 3, or of metallurgical, biological, and chemical samples up to 3 x 5.5 in. Among features: (1) Cloverleaf shelf with "petals" that can be adjusted with finger-tip pressure to secure proper size hole for each crucible; (2) shelves adjustable along ribs attached to lid; (3) one to six shelves may be used in each desiccator—of plain or cloverleaf design, or a combination of both types. Jar is 3.5 in. diam. by 6.625 in. high.—*Bethlehem Apparatus Co., Hallertown, Penna.*

Mention No. 1042 when filling out card.

Moment-balance Scale

New "Model 4112-A Special Laboratory Moment Balance Scale" is a specially-designed model of maker's



"Shadowgraph Scale" for selecting and classifying high-speed rotating parts such as gas-turbine buckets.—*The Exact Weight Scale Co., 944 West Fifth Ave., Columbus 8, Ohio.*

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Box for Analytical Weights

New Tenite II plastic box for maker's gold weights is more versatile, smaller, more compact, and less ex-

pensive than wooden box formerly used. It is molded by Auburn Button Works, Inc., Auburn, N. Y., for *William Ainsworth & Sons, Inc., 2151 Lawrence St., Denver 2, Colo.*

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New "Su-5A Alpha-Beta-Gamma Survey Meter" has optional probe for alpha detection. May be used as radiation dosage rate meter and low-level contamination monitor; is lightweight and battery operated. Four scale ranges of 0.02, 0.2, 2.0 and 20 mr./hr. correspond to CPM ranges of 100, 1000, 10,000 and 100,000. Case-mounted radioactive source checks operation. "P-17 Side Window Probe" separates

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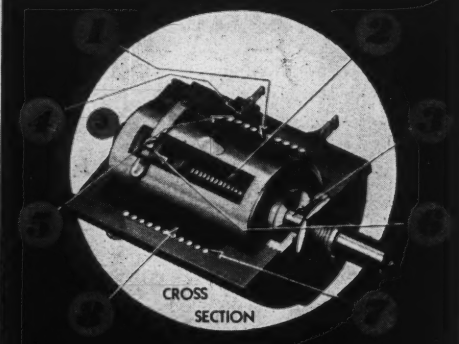

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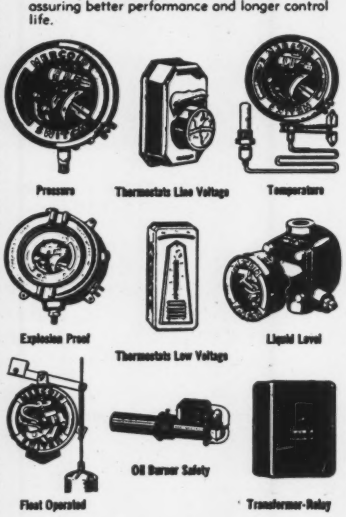

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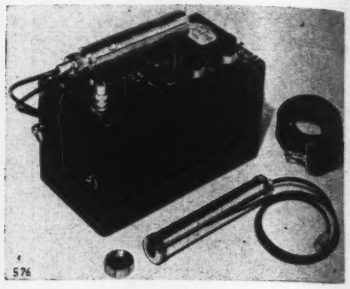

gamma radiation in presence of beta radiation. "P-18 End Window Probe" permits monitoring of low-energy beta emitters and alpha particles.—*Tracerlab, Inc.*, 130 *High St., Boston* 10, *Mass.*

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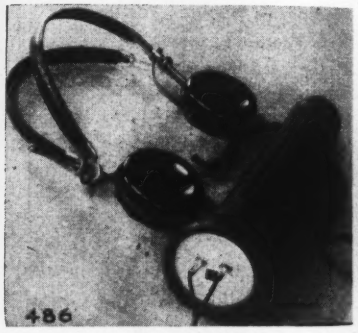
New "Model 101" features: (1) lowest possible battery cost per hour of use; (2) novel circuit (patents pending) requiring charging two or three



times per day of constant use by operation of a pushbutton; (3) sensitive to gamma radiation from uranium & thorium ores; (4) average background about 16 counts/minute; (5) long-lived halogen-quenched Geiger-Mueller tube with flat and long plateau, over four times threshold voltage; (6) normal battery life, 1 year.—*Morgan Instruments Co.*, 21420 *Valerio St., Canoga Park, Calif.*

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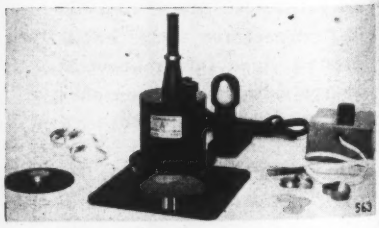
Analysis-unit Charger

New "Model L-22 Charger" recharges company's "L-75 Analysis Unit." Dimensions: 3 x 3.75 x 2.75 in.

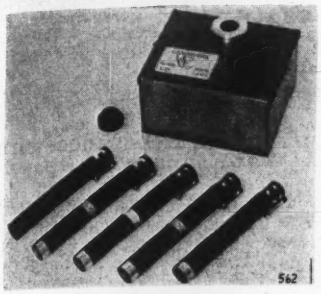


Battery life equals shelf life.—*Landsverk Electrometer Co.*, 140 *West Providencia Ave., Burbank, Calif.*

Mention No. 1047 when filling out card.

Dosimeter Charger

New "Model L-21 Dosimeter Charger" charges all current "Landsverk" dosimeters. Metal case has gray



finish. Dimensions: 3 x 3.75 x 2.75 in. Battery life equals shelf life.—*Landsverk Electrometer Co., 140 West Providencia Ave., Burbank, Calif.*

Mention No. 1048 when filling out card.

Radiation Absorber Changer

New automatic absorber-changer attachment consists of slide and switch assembly and set of 25 calibrated aluminum absorbers. With attachment, automatic sample changer can position

25 absorbers over radioactive source for making absorption curves. Absorbers range from 1.6 mg./cm.^{2} to 1.5 g./cm.^{2}, have 1 in. diameter, and are made of aluminum foil.—*Tracerlab, Inc., 130 High St., Boston 10, Mass.*

Mention No. 1049 when filling out card.

Scintillation Detector

New "Model SC-2" detector has a 5819 photomultiplier tube in brass cylinder. Uses a NaI-Thallium activated crystal as an efficient end-window

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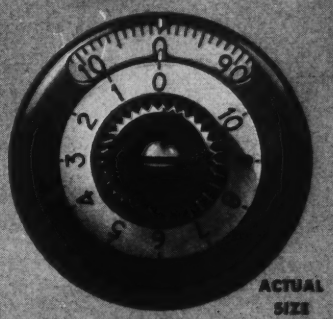
Microdial is composed of two concentrically mounted dials . . . one for counting increments of each turn and the other for counting turns. The incremental dial has 100 equal divisions and is attached rigidly to the shaft so there is no backlash. Thus the contact position is indicated to an indexed accuracy of 1 part in 1000. Rotation is continuous in either direction. There are no stops on the Microdial assembly.

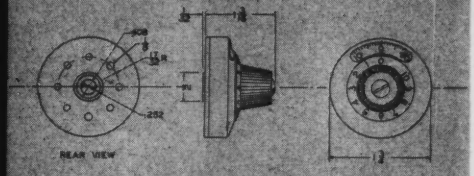
COMPACT . . . Microdial has same O.D. as Micropot . . . requires no more panel space.

CLEAR READING . . . Forced fast-reading tests showed only 1/20th as many errors with Microdial open window as with next most legible dial. Turn counter distinguishes between 0 and 10 turn readings, and accelerates to avoid confusion on readings near integral turns. Precise readings are made from larger dial with maximum separation of graduations and wide angle visibility.

CONVENIENT . . . delivered completely assembled with dials synchronized. Easily mounted in a few seconds. All dials may be locked.



ACTUAL SIZE



REAR VIEW

Microdial . . . turn-counting dial, primarily designed for use on Micropot ten turn linear potentiometers . . . use it on any multiturn device having ten turns or less.

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PERCENTAGE: Continuously variable from 0 to 100%.

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OUTPUT

LEVEL: Continuously variable from 0.3 microvolt to 0.1 volt balanced to ground (measured at 100% modulation level).

DIMENSIONS: Height—58¾" Width—28¼" Depth—25½"

POWER SUPPLY: 117 volts, 60 cycles, 700 watts.

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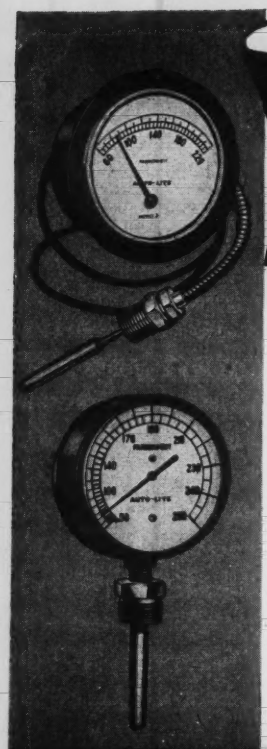

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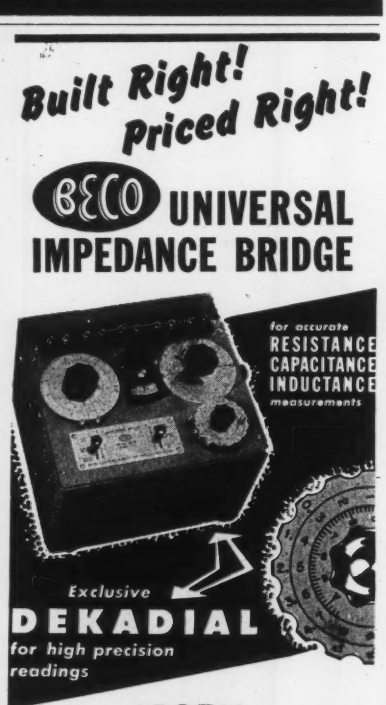

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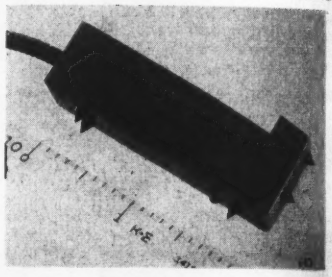
NEW INSTRUMENTS

gamma detector. Comes with cable for use in conjunction with any commercial scaler or count-rate-meter employing pulse amplifier, discriminator, and regulated supply.—*Nuclear Research and Development, Inc.*, 1094 *Sutter Ave., St. Louis* 5, *Mo.*

Mention No. 1050 when filling out card.

Unbonded Resistance-wire Strain Gage

New unbonded resistance-wire strain gage is furnished with knife edges for specimen engagement, and exhibits electrical characteristics similar to cemented type. Over-all dimensions are 2.25 x 0.75 x 0.75 in. Two active bridge



arms are incorporated. Gage may be used immediately upon attachment to specimen and may be used repeatedly without destruction of gage.—*Statham Laboratories, Inc.*, 12401 *W. Olympic Blvd., Los Angeles, Calif.*

Mention No. 1051 when filling out card.

Test-prod Adaptor

New "Klipzon type-L Longie Adaptor" provides a slender, insulated point for reaching into crowded circuits.

Self-holding point permits measurements with both hands free. Adaptors clip onto wires from finest to #12 B & S ga. and slip onto standard test prods. —*United Technical Laboratories, Morristown, N. J.*

Mention No. 1052 when filling out card.

Input and Output Networks

New "Series 1130" branching networks are multiple input and output networks used (1) to equalize incoming signal levels, (2) to combine two or more incoming lines into a single outgoing line, or (3) to divide one incoming line into two or more outgoing lines. Available in either balanced-H or unbalanced-T circuits. Resistors are precision wire-wound. Maximum level is 24 VU. Provides up to 10 inputs or outputs. Any standard impedance is available. Frequency range is zero to 50 kc. for most values.—*The Daven Co., 191 Central Ave., Newark, N. J.*

Mention No. 1053 when filling out card.

Audio Amplifier

New components for "Williamson" high-fidelity audio amplifier are now available at low cost. Components include "A-8054" high-fidelity output transformer, "PC8412" power transformer, and "C-1411" filter choke.—*Standard Transformer Corp.*, 3580 *Elston Ave., Chicago* 18, *Ill.*

Mention No. 1054 when filling out card.

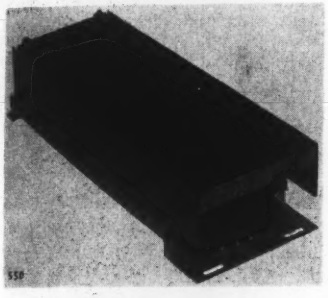
High-accuracy Capacitors

New "Type 950 Series" capacitors are shielded, sealed hermetically and intended primarily for precision applications. Capacitance tolerances are ± 1 percent up to 2200 uuf., and ± 5 percent up to 6000 uuf. Rated at 500 volts d.c. working.—*Centralab Div., Globe-Union, Inc.*, 900 *E. Keefe Ave., Milwaukee* 1, *Wis.*

Mention No. 1055 when filling out card.

Plug-in Chassis

New "Cinema 8862 Series Plug-in Chassis" is chassis with built-in ten-



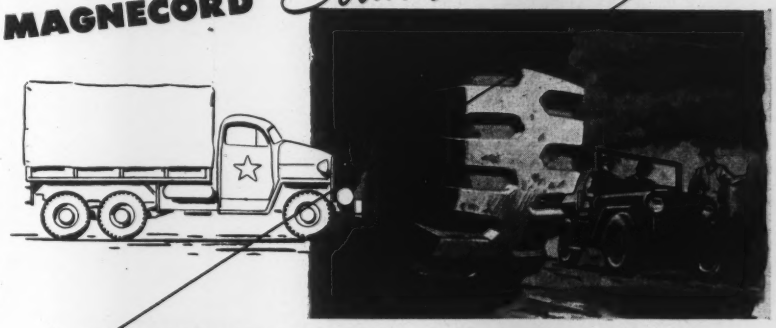
element connectors. Furnished in kit form. Open-leaf spring-type contacts are 18-percent nickel silver. One plate is shock mounted.—*Cinema Engineering Co.*, 1510 *West Verdugo Ave., Burbank, Calif.*

Mention No. 1056 when filling out card.

High-gain Relay

New "Series 1816" relay has been redesigned for improved performance. Insulation creepage path has been increased: standard 1/16-in. minimum between all current conductors and frame; ¼ in. on special order. With 5-milliamp. coil, contacts are rated 15 amps. 115 v or 7½ amps. 230 v. S-p.d-t. or d-p.d-t. contact arrangements are standard. New relay has high differential between pull-in and drop-out: ratio about 5 to 1.5. Up to five seconds delay can be had with 200 mfd. capacitance. Minimum sep-

MAGNECORD Sound Research



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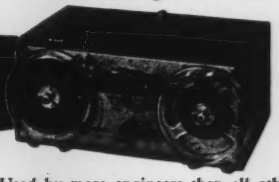

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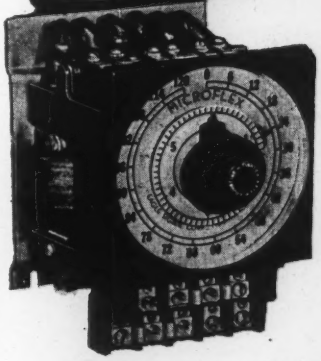

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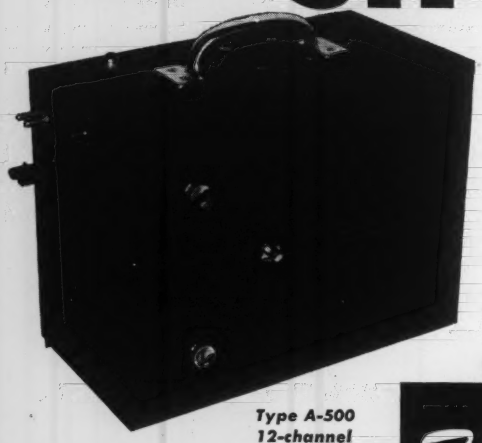

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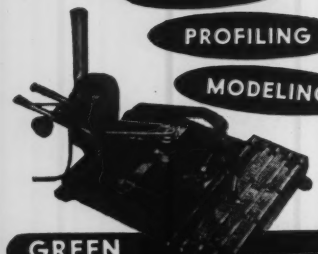

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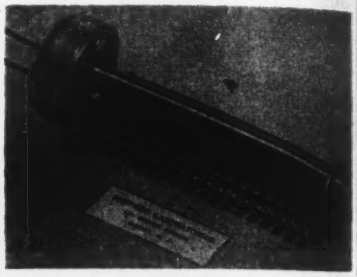
NEW INSTRUMENTS

aration between core and armature is controlled by a shim of 0.001-in. brass bonded to end of core.—*Assembly Products, Inc., Chagrin Falls, Ohio.*

Mention No. 1057 when filling out card.

Multiple Relay

New "gang" type multiple switching device is mounted on rubber feet and is driven by heavy-duty solenoid. Switch contacts are rated at 10 amp. 125



v.a.c., and 5 amp. 250 v.a.c. Model shown makes and breaks 17 circuits at each actuation; others are available with larger or smaller switch complements. Voltages required for actuation range from 3 to 300 v.d.c.—*Shepard Laboratories, 430 Morris Ave., Summit, N. J.*

Mention No. 1058 when filling out card.

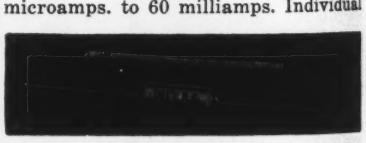
Vitreous-enamel Rheostats

New line of vitreous enamel power rheostats results from undersigned concern purchasing inventory, equipment, and patents for round power rheostats formerly made by Rex Rheostat Co., Baldwin, L. I. New rheostats will be available in seven sizes, from 50 to 500 watts, interchangeable with those produced by rest of industry but featuring patented hinged contact arm.—*Resistor Div., P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis 6, Ind.*

Mention No. 1059 when filling out card.

Sealed Selenium Rectifiers

New hermetically-sealed selenium rectifiers are assembled in half-wave cartridges with current ratings from 300 microamps. to 60 milliamps. Individual

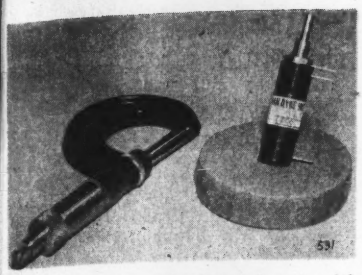


cartridges accommodate up to 400 cell elements with d-c. voltage ratings up to 8,000 volts per cartridge. Connecting a number of cartridges in series permits voltages up to 250,000 to be obtained.—*International Rectifier Corp., 6809 S. Victoria Ave., Los Angeles 43, Calif.*

Mention No. 1060 when filling out card.

Subminiature VDR

New "Type H-50" helical VDR has resistance element, 12 inches long, contained in case 0.5 inch in diameter.



Shaft moves linearly in and out with rotation, and any setting can be maintained under conditions up to 20 G acceleration in any plant without u e of additional locking devices. Shaft and wiper are electrically connected, and insulating bushings are furnished for mounting on metal panels.—*Van Dyke Instruments, Inc.*, 1927 *First Ave. South, P.O. Box* 355, *St. Petersburg* 1, *Fla.*

Mention No. 1061 when filling out card.

Limit Switch

New "du.op" switch is for applications requiring a compact light-weight limit switch. As a direct-acting switch, it has no inherent bounce characteris-

tics. Mechanical lost motion is said to be eliminated. Each contact blade is a solid piece of metal riveted to terminals, reducing electrical resistance. Contact arrangement is s-p.d-t. spring return. Contacts will handle up to 20 amperes, 125 v.a.c. non-inductive.—*General Control Co., Boston* 34, *Mass.*

Mention No. 1062 when filling out card.

Attenuator Switches

New line of attenuator switches includes 12 round, single-deck units in one-and two-pole types with up to 60 contact positions and with rotations ranging from 144 to 360 degrees. Obtainable with or without detent mechanism. All have silver alloy contacts, wiper arms and collector rings.—*Shallcross Mfg. Co., Collingdale, Penna.*

Mention No. 1063 when filling out card.

Rotary Switch Actuators

New series of rotary switch-actuating mechanisms provide intermittent pulsed reciprocating rotational motion

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*Patent applied for.
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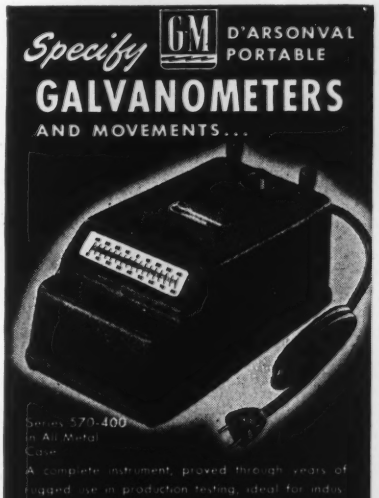
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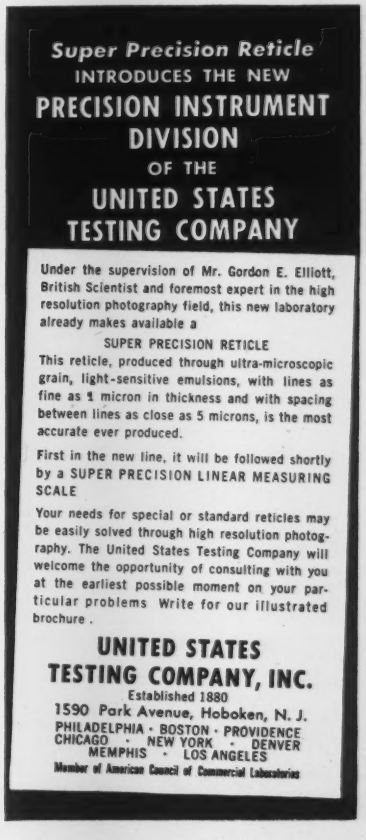
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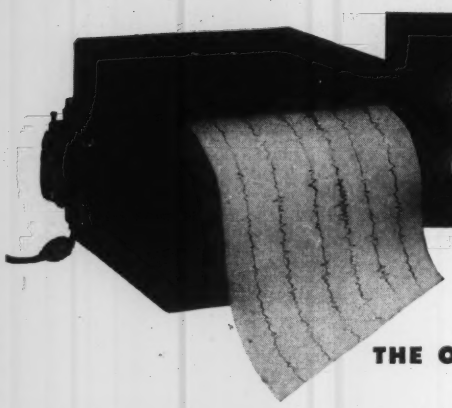

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of up to 330 degrees with torques tailored to suit individual requirements. Drive consists of miniature motor in circuit permitting rapid reciprocal switching up to 10 cycles per second. Applications are in fields where rapid rotary action with no lateral thrust is needed.—*General Precision Laboratory, Inc., Pleasantville, N. Y.*

Mention No. 1064 when filling out card.

Miniature Fuse Extractor Post

New fuse extractor post for "3 A G" fuses reduces behind-panel distance by one inch. Balance of strength between Bakelite and metal nut eliminates danger of breaking post by over-tightening mounting nut. All-purpose terminal (solder, wrap-around or quick disconnect) is used on both side and bottom terminal. Knife-edge bottom contact effectively cuts through any surface accumulation on fuse cap to assure low-resistance electrical contact. Side terminal and internal metal ring which makes contact with top of fuse are in one piece: soldered or welded joint. It is not necessary to remove fuse in order to test it: at top of knob is a hole for a test prod.—*Littelfuse Inc., 4757 N. Ravenswood, Chicago, Ill.*

Mention No. 1065 when filling out card.

Video Switching and Mixing Equipment

New video switching and mixing equipment comprises a Nine-Channel Switch Unit, a Mixer Line Amplifier and a Low-Voltage Supply, for greatly simplified master control switching or studio switching in telecasting routine. —*Television Transmitter Div., Allen B. DuMont Labs., Inc., 1000 Main Ave., Clifton, N. J.*

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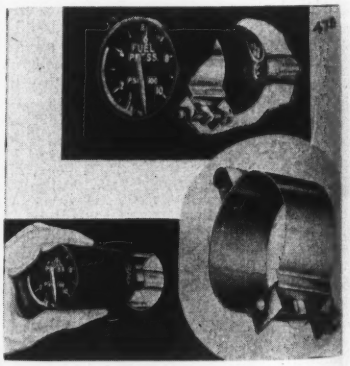
Instrument Mounting Clamp

New instrument mounting clamp, permitting removal of instrument from dial side of panel, is installed on rear of

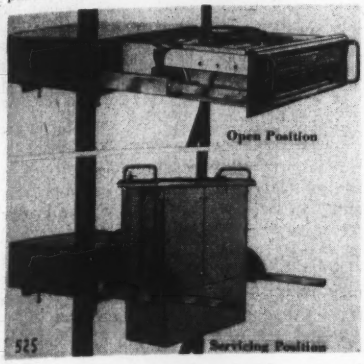


panel behind cutout. Fastening or removal is accomplished by adjusting one screw, minimizing assembly and servicing time. Conforms to specification MIL-C-5818.—*Marman Products Co., Inc., Inglewood, Calif.*

Mention No. 1067 when filling out card.

Chassis Slides

New precision slides can be applied to any device where access to parts of motion of equipment is de-

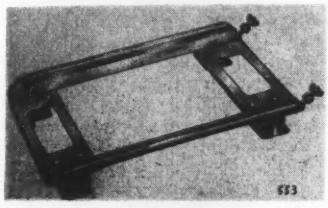


sired. Locking device holds moved unit when fully extended, permitting quick access to operating parts. Tilting provision has simple tripping mechanism for servicing.—*Grant Pulley & Hardware Co.*, 31-85 *Whitestone Parkway, Flushing. L. I., N. Y.*

Mention No. 1068 when filling out card.

Vibration Isolators

New ruggedized unit vibration isolators cover load ranges between ¼

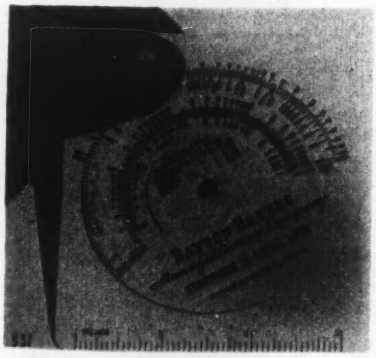


lb. and 40 lbs. per unit mount, and are interchangeable with other isolators now in use. Available both in air-damped type and in "All-Metl" type. —*Barry Corp.*, 820 *Pleasant St., Watertown 72, Mass.*

Mention No. 1069 when filling out card.

Metal-weight Calculator

New calculator determines weight of steel, aluminum, iron, copper, bronze



and lead sheets. Thickness is set opposite width; weight is opposite length. May be obtained free of charge by making request on company letterhead. —*Dayton Rogers Mfg. Co.*, 2824-13*th Ave., South, Minneapolis 7, Minn.*

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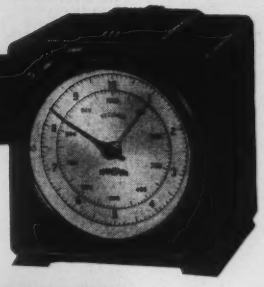
Standard TIMERS



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T-1

Model	Scale Divisions	Totalizes	Accuracy
S-100	1 5 sec.	6000 sec.	± .1 sec.
S-60	1 5 sec.	60 min.	± 1 sec.
SM-60	1 100 min.	60 min.	± .002 min.
S-10	1 10 sec.	1000 sec.	± .02 sec.
S-6	1 1000 min.	10 min.	± .0002 min.
S-1	1 100 sec.	60 sec.	± .01 sec.
MST	1 1000 sec.	360 sec.	± .001 sec.
MST-500	1 1000 sec.	30 sec.	± .002 sec.

Write for Timer Bulletin 153

Other Products: Chrono-Tachometers, Custom-Built Laboratory Test and Distribution Panels

THE Standard Electric Time Co.

93 Logan Street STANDARD FOUNDED 1884 **Springfield, Mass.**

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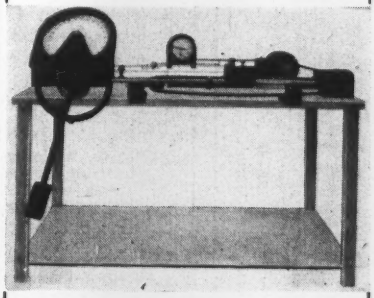
TENSILE STRENGTH **TESTERS**



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for VERY LIGHT MATERIALS

Horizontal type—Bench Model

Various ranges up to maximum of 25 lbs.

With or without elongation indicator.

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TESTING INSTRUMENT CO., INC.

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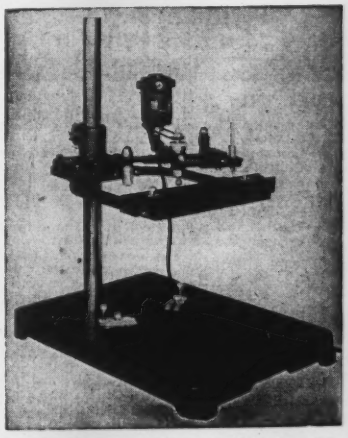
MICO ENGRAVER

Model 253



A further adaptation of the already proven Mico Engraver, Model 252. Will perform accurate engraving on panels 19-inches wide and of unlimited length. Accommodates work up to 19-inches high.

Catalog on request

MICO INSTRUMENT CO.

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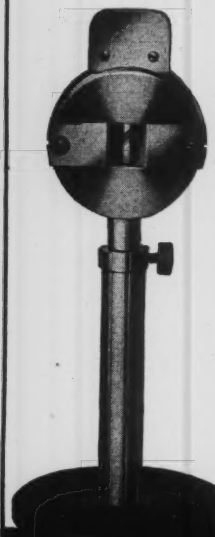
EPLAB

Thermopiles



For many years the thermopile has been the accepted instrument for measuring Radiant Heat from Radiant Heaters at the American Gas Association Testing Laboratory in Cleveland, Ohio. Since 1930, when Vandaveer first described his work in this field,* an Eppley thermopile has been used for this purpose in hundreds of tests and the results have been consistent and accurate to within 1 per cent.

This is but one of many applications in the field of radiant energy measurements for which Eppley Thermopiles are ideally suited. They may be obtained with windows of different materials, and various types of black are available for receiver coatings.

All Eppley Thermopiles are supplied with a certificate of calibration, this calibration being made against a Standard Lamp from the National Bureau of Standards.

If you have a problem involving the measurement of radiant energy we invite you to write us, describing your problem in as much detail as possible. We will be glad to make recommendations and there will be no obligation.

*Vandaveer, *Industrial & Engineering Chemistry*, Vol. 22, page 596, June 1930.

BULLETIN No. 3 ON REQUEST

THE EPPLEY LABORATORY, INC.

SCIENTIFIC INSTRUMENTS

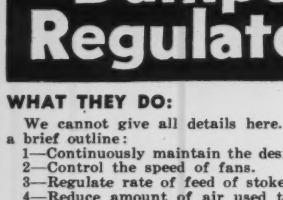
NEWPORT, RHODE ISLAND, U. S. A.

ATLAS Damper Regulators

WHAT THEY DO:

We cannot give all details here. But, here is a brief outline:

1—Continuously maintain the desired pressure.
2—Control the speed of fans.
3—Regulate rate of feed of stokers.
4—Reduce amount of air used to the desired minimum.
5—Higher and more efficient furnace temperature is attained and maintained.
6—Regulate CO_2 and avoid CO.
7—Save considerable fuel.
8—Save labor.
9—Quickly pay for themselves.



ATLAS Damper Regulator No. 502. For boiler pressures up to 150 lb.

Installed on almost any boiler they are an important economy factor. Use the coupon at the right.

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292 South St., Newark 5, N. J.

Represented in all Principal Cities

ATLAS VALVE CO., 292 South St., Newark 5, N. J.
☐ Please send Bulletin 4A giving data on ATLAS Damper Regulators. Also, send data on the ATLAS products checked below.

☐☐ Temperature Regulators
☐☐ Combustion Control Systems
☐☐ Water Regulators
☐☐ Reducing Valves
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☐☐☐ Exhaust Control Systems
☐☐☐ Pump Governors
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Continued from page 1177

is maximum across the L-C circuit, the main-line current is minimum, and the circulating current is maximum.

Uses of Resonant Circuits

Resonant circuits are used in two ways—(1) to separate frequencies and (2) to generate oscillatory signals.

Filters. For separating frequencies, or for passing or rejecting one frequency from others, series- or parallel-resonant circuits are used in *filters*. A parallel-resonant circuit in series with the signal (Fig. 3-8,A) offers high impedance to the desired frequency and a low impedance to all other frequencies. Similarly, a series-resonant circuit in parallel with the signal (Fig. 3-8,B) passes all signals except the resonant frequency. Such filters are called *wave traps*. Combinations of series- and parallel-resonant circuits are used to pass or reject certain bands of frequencies.

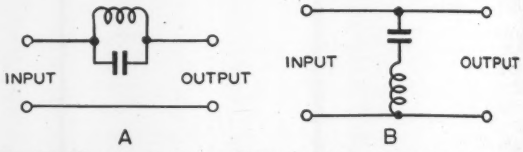


Fig. 3-8. Wave traps. A, parallel-resonant trap in series with signal; B, series-resonant trap in shunt with signal.

Oscillating tanks. An important characteristic of the circulating current in a parallel-resonant tank is that there is interchange of energy between the capacitor and the inductor. This interchange of energy is such that if there were no resistance in the tank, the current would oscillate back and forth forever once the capacitor is charged. (For this reason the parallel-resonant circuit is called an oscillating *tank*.) However, as there always is some resistance in the oscillator, there is some I^2R power loss and the oscillation gradually dies down unless energy is fed into the tank. Only a tiny amount of energy need be added to tanks with high Q (low resistance) to sustain oscillation. This is the principle by which oscillations are induced and sustained in parallel-resonant tanks. Such tanks are used commonly as frequency-determining elements in signal generators. An oscillator or signal generator is simply a device which adds the proper amount of energy to the tank at the proper time to sustain oscillation. By using high-Q components, a single desired frequency can be obtained. The frequency can be changed by changing the value of L or C in the tank.

TEST ITEMS FOR—III. IMPEDANCE AND RESONANCE

3-1. The total opposition of a circuit containing resistors, capacitors, and inductors to alternating current is called
(a) resistance
(b) reactance
(c) impedance
(d) conductance

3-2. Most characteristic curves are plots of
(a) direct voltage vs. direct current
(b) direct voltage vs. alternating voltage
(c) alternating voltage vs. alternating current
(d) alternating voltage vs. direct current

3-3. The characteristic curve of a resistor is
(a) a straight line with positive slope
(b) a straight line with negative slope
(c) a segment of a circle
(d) a segment of a parabola

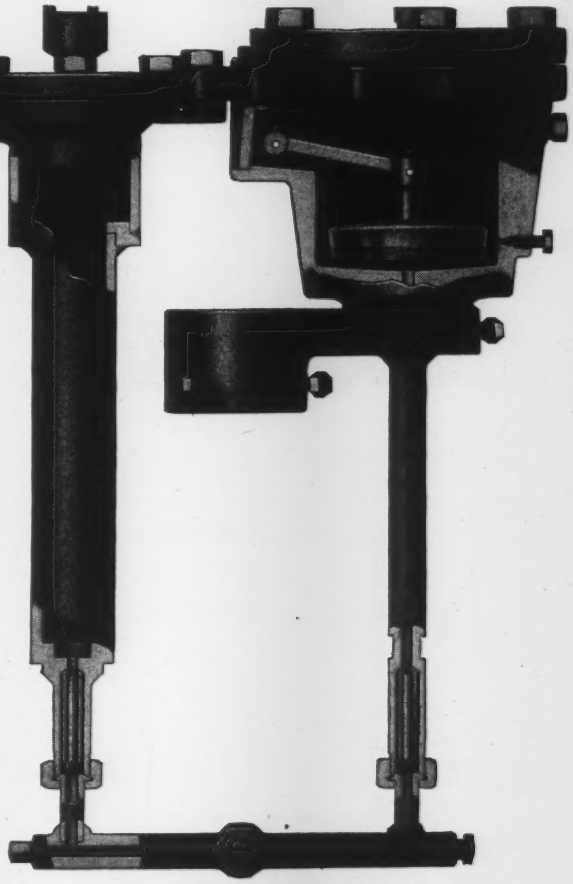
3-4. Which part of a characteristic curve of a device is a measure of the resistance of the device to a.c.?
(a) The impedance scale
(b) The alternating-current scales
(c) The ratio E/I
(d) The slope

3-5. A high-impedance point on a characteristic curve has
(a) high current
(b) low current
(c) high slope
(d) low slope

3-6. Resistance and reactance can not be added algebraically because they
(a) are not measured in the same units
(b) are both oppositions to current
(c) have different phase relations
(d) have different amplitudes

3-7. To find the impedance of

Joe—You can't beat this Taylor Mercury Manometer for performance. There's no seizing — thanks to TEFLON BEARING



SATISFIED customers tell us the "Teflon" Pressure-Tight Bearing makes the new Taylor Mercury Manometer seize-proof and practically leak-proof. It's ideal wherever you need something *better* than present differential pressure measuring instruments. Teflon is a synthetic plastic that minimizes friction and eliminates seizing common to metal-to-metal bearings. It resists corrosion because of unmatched chemical inertness. That's why this Taylor Manometer ends pressure-tight bearing troubles that may have blocked precise control for years. Other features:

1. **Great Power**—thanks to extra-big float with extra-long travel. Micro-inch finished shaft with Teflon bearings "float" this power right through to the pen.

2. **High Accuracy**—inherent straight-line calibration.

3. **Positive Actuation**—high energy output. **(a) Big 3 5/16" float. (b) Long float travel—1".** (c) **Simple lever system.** (d) **Teflon in pressure-tight bearing surfaces** for efficient use of power. (e) **Jewelled thrust bearing.**

4. **Dependable Performance.** (a) **Submerged check valves give** positive shut-off. (b) **Unique damping valve** adjustable under full pressure without leakage. (c) **Ample room** in mercury chambers to accommodate surges or pulsating flows. (d) **Teflon holds pressure,** yet lets shaft turn freely, giving long service.

5. **Great Adaptability.** (a) **Six interchangeable range tubes:** 10", 20", 50", 100", 200" and 400" of water. (b) All ranges except 10" may be over or under ranged 33⅓%. (c) Both side and top pressure connections. (d) **Two manometers** can be mounted on back of single case for recording two Flows or for Ratio-Flow control. (e) A union coupling prevents distortion of bearing housing—eliminates binding or friction caused by wrench-torque.

6. **Ease of Maintenance.** (a) **Low pressure chamber cover** permits easy access to float and lever arm during calibration. (b) **Entire pressure-tight bearing** easily and economically replaced.

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MEANS
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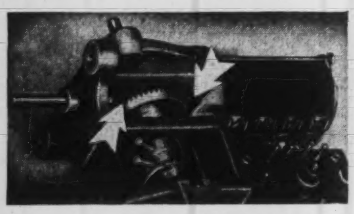

MECHANICAL TOLERANCES OF FAIRCHILD POTENTIOMETERS

Concentricity, shaft to pilot, .0025 in. or better.
Radial shaft play, .0015 in. or better.
Shaft to mounting plate squareness, to .001 in./in.

There's more to a precision potentiometer than accurate windings. In order that required high *electrical* tolerances be held, it is absolutely essential that such parts as the shaft, mounting plate, and housing be designed and built for highest *mechanical* accuracy.

Take the radar control assembly illustrated above. Its gears are precision cut to eliminate backlash and binding, but the care that went into their manufacture could be completely nullified if the potentiometer coupled to them was not mechanically precise. In this case, overall accuracy is assured by using a Fairchild precision unit built from parts *designed and made* by Fairchild.

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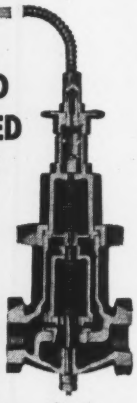
PRECISION POTENTIOMETERS

SELF -CONTAINED -CONTROLLED -SUFFICIENT -RELIANT



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The patented Farris Stacon Temperature Regulator is easily the most independent regulator available today. It's unique. It stands alone. It's trustworthy. It needs no watching. It's perfect for the man who wants no cause for worry . . . who wants to relax in the sure knowledge that his temperatures are constant.

Here's why Stacon stands alone in the field. It has no packing glands to leak or bind . . . the stem moves freely. The liquid in the bulb flashes to vapor in the power bellows, assuring hairtrigger response to move the disc. It operates with unbelievable accuracy—to within plus or minus 1 degree—and it operates with that accuracy under *all* conditions. Stacon provides air-operated accuracy at low, self-operated cost.

Get the details on the one truly outstanding temperature regulator—Stacon. Send for Bulletin 50-1000 to get all the details.

*Patented and Patents Pending

Farris Stacon Corporation
536 COMMERCIAL AVE. PALISADES PARK, N. J.

a circuit with resistance and reactance in parallel, you use vector addition of the
(a) resistance and reactance
(b) currents in each branch
(c) voltage in each branch
(c) voltage across each branch
(d) generator current and voltage

3-8. To find the impedance of a circuit with resistance and reactance in series, you use vector addition of the
(a) resistance and reactance
(b) currents in each element
(c) reactances only
(d) generator current and voltage

3-9. True power in a series circuit with reactance depends on the current and
(a) resistance only
(b) inductive reactance only
(c) capacitive reactance only
(d) all the above

3-10. The product of E (applied generator voltage) and I (circuit current) in a reactive circuit is called
(a) true power
(b) apparent power
(c) power factor
(d) phase angle

3-11. The phase angle in a reactive circuit is the angle between
(a) inductive voltage and capacitive voltage
(b) reactance and resistance
(c) generator voltage and generator current
(d) all the above

3-12. The power factor in a reactive circuit is the
(a) tangent of the phase angle
(b) cosine of the phase angle
(c) phase angle
(d) true power

3-13. In order to obtain the true power in a reactive circuit, it is necessary to multiply the apparent power by the
(a) power factor
(b) phase angle
(c) applied voltage
(d) circuit current

3-14. Power is transferred with maximum efficiency from circuit A to circuit B when the
(a) voltage across circuit B is a maximum
(b) current in circuit B is a minimum
(c) impedance of B matches that of A
(d) impedance of B is a maximum

3-15. At frequencies below resonance, a series-resonant circuit appears like
(a) a low reactance
(b) a low resistance
(c) a capacitor and a resistor in series
(d) an inductor and a resistor in series

3-16. The impedance of a series-resonant circuit is minimum
(a) below resonance
(b) at resonance
(c) above resonance
(d) when not resonant

3-17. Which of the following out-of-phase voltages can be added or subtracted algebraically?
(a) Voltages out of phase by 90 degrees.
(b) Voltages out of phase by 180 degrees.
(c) Any out-of-phase voltages.
(d) None of the above.

3-18. A circuit is said to be resonant when
(a) it contains no resistance
(b) capacitance equals resistance
(c) capacitance equals inductance
(d) capacitive reactance equals inductive reactance

3-19. The formula
$Z = \sqrt{R^2 + (X_L - X_C)^2}$
is used for finding the impedance of a circuit containing resistance and reactance in
(a) series only
(b) parallel only
(c) resonant circuits only
(d) any circuit

3-20. The resonant frequency of a circuit containing inductance (L) and capacitance (C) can be increased by
(a) decreasing L or increasing C
(b) increasing L or decreasing C
(c) decreasing L or C
(d) increasing L or C

3-21. The voltage drop across the capacitor in a series-resonant circuit can be
(a) in phase with the voltage drop across the inductor
(b) only as high as the applied generator voltage
(c) higher than the applied generator voltage
(d) in phase with the current through the capacitor

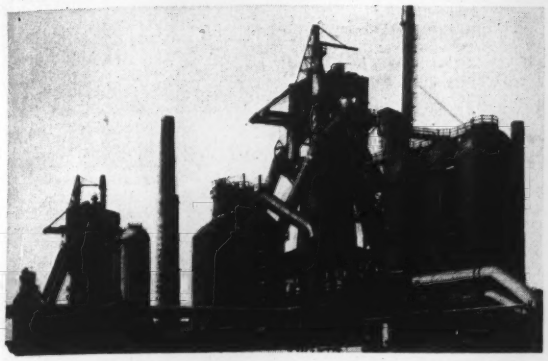
3-22. The Q of a coil is the ratio of
(a) inductance to resistance of the coil
(b) inductive reactance to resistance of the coil
(c) inductive reactance to capacitive reactance
(d) inductance to capacitance of the coil

3-23. A high-quality coil has
(a) low Q
(b) high Q
(c) low inductance
(d) high inductance

3-24. A parallel-resonant tank at resonance is characterized by
(a) small line current
(b) high impedance
(c) high circulating current
(d) all the above

3-25. If a series-resonant circuit is to pass a signal of one frequency and to reject all other frequencies, it should be
(a) in series with the line

CAMBRIDGE TOP GAS ANALYZERS



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here's proof...

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A 300 psi over-range pressure was alternately applied in the normal direction and then in the reverse direction approximately *20 times a minute,* continuously—day and night—*for three weeks!* At the conclusion of the test—after more than one-half million differential over-ranges in each direction—the instrument was checked for zero and calibration; *it had changed* less than one per cent! AND *no maintenance or parts replacement was required!*

less maintenance...

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EASY TO OPERATE—Unskilled personnel can put a BARTON in operation without danger of damage to the meter.

CLEANING ISN'T NEEDED—a BARTON drains or vents itself completely. No pockets to trap condensates. No floats, chains, or links to corrode. Assures permanent positive accuracy.

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- Torque-tube Drive—no pressure bearings.
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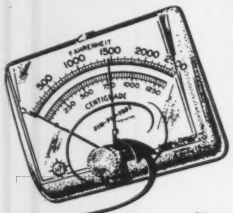
CONTACT METER RELAYS



sensitive to

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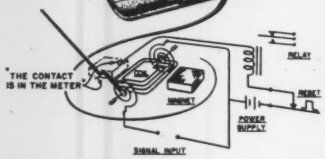

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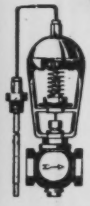

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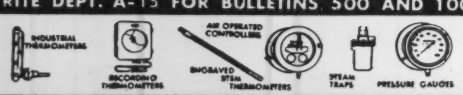

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(b) in parallel with the line
(c) a low-Q circuit
(d) nonresonant

3-26. Filters can contain
(a) series-resonant circuits only
(b) parallel-resonant circuts only
(c) combinations of series- and parallel-resonant circuits
(d) all the above

3-27. A parallel-resonant circuit is called a tank because it
(a) has a storage capacitor which can be charged
(b) oscillates for a time after being charged
(c) is resonant at one frequency
(d) has high Q

3-28. The circulating current in a parallel-resonant tank flows in
(a) the generator only
(b) the line only
(c) the tank only
(d) all the above

3-29. A series-resonant circuit differs from a parallel-resonant tank in that the former has
(a) a resonant frequency
(b) equal reactances at resonance
(c) inductance and capacitance
(d) minimum impedance at resonance

3-30. The frequency-determining element in a signal generator usually is a
(a) low resistance
(b) wave trap
(c) parallel-resonant tank
(d) series-resonant circuit

Tunnel Instrumentation

Continued from page 1180

ventilating equipment supplies more air for the tunnels. Besides conserving power used in ventilating-equipment motors, the detecting instruments act as gages of fresh air requirements and provide a permanent record of carbon-monoxide concentrations.

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GREAT NECK, N. Y.—High-speed predetermined electronic counters are used to package bottle caps in precise predetermined quantities, thereby eliminating costly over- or under-counts normally associated with ratio scale weighing.

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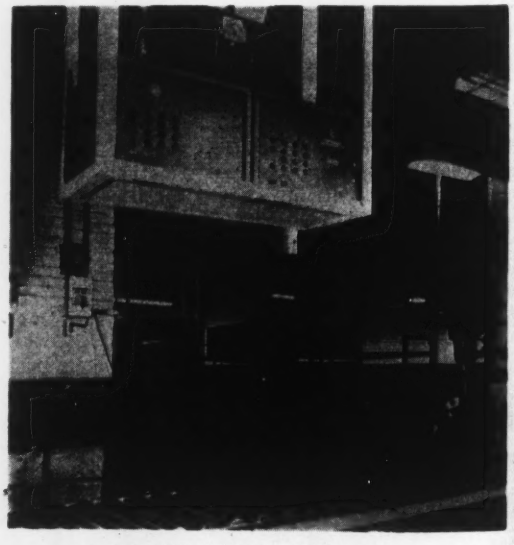

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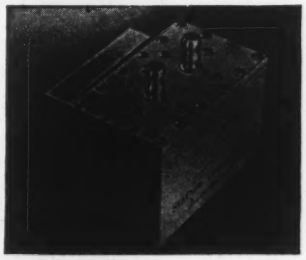

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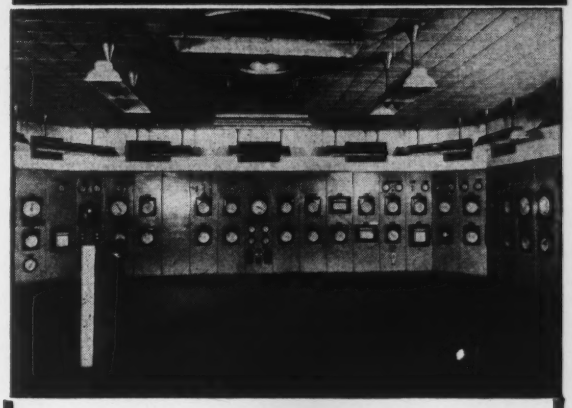

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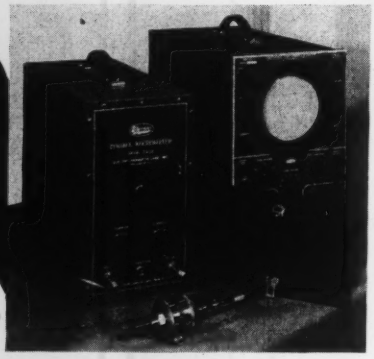

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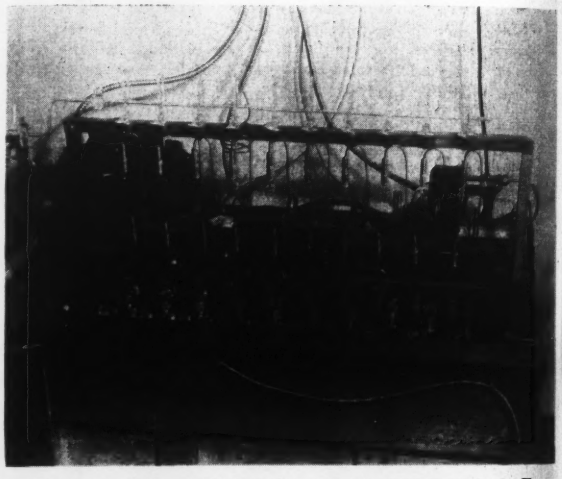
mechanism at the predetermined count, they provide a secondary control by energizing a shaker mechanism each time 2,000 bottlecaps are counted. This mechanism shakes the caps down firmly in the box to prevent scratching due to movement during shipment.

New pH Standards

WASHINGTON, D. C.—Four new pH standards which provide fixed points at the upper and lower ends of a standard pH scale have been selected by chemists of the National Bureau of Standards, according to Technical Report 1472.

The National Bureau of Standards has long recognized the need for a universally accepted scale of acidity, analogous to the International Temperature Scale. To encourage the adoption of such a scale the Bureau has, for several years, distributed three standard samples of known pH. These samples fix the scale at pH 4, 7, and 9; the pH of intermediate points is obtained by interpolation. Unfortunately this scale is not uniform at its ends, and additional standards are needed to reduce the error of measurement at low and high pH.



Cells without liquid junction for accurate measurement of pH.

In the course of the work 41 solutions were examined. The following four standards were selected:

1. A mixture of sodium bicarbonate and sodium carbonate, both at 0.025 molar concentration, with a pH of about 10 at room temperature.
2. A 0.01 molar solution of trisodium phosphate, pH about 11.7.
3. A solution of potassium hydrogen tartrate saturated at room temperature, pH about 3.6.
4. A 0.01 molar solution of potassium tetroxalate, pH about 2.1.

Although the new standards lengthen the accurate portion of the scale in both directions, the measured pH of highly acid and highly alkaline solutions still must be assigned an uncertainty of at least 0.03 unit.

The figure shows cells without liquid junction for accurate determination of the pH of solutions of standard pH samples issued by the Bureau. The electromotive force generated across highly reproducible hydrogen and silver-silver chloride electrodes immersed in the solution (to which chloride has been added) is measured on a potentiometer. Ten cells are shown set into a constant-temperature bath. In each cell, hydrogen enters through the glass tube in the rear, bubbles slowly through the cells and finds its way into the hydrogen-electrode compartment. Here it is absorbed on platinum foil coated lightly with spongy platinum, which thus acts as a hydrogen electrode. The cell at the left is equipped with two silver-silver chloride electrodes prepared by partial conversion of metallic silver

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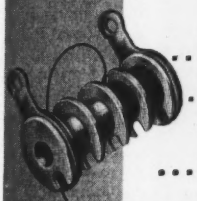

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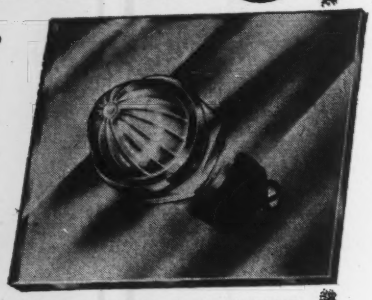

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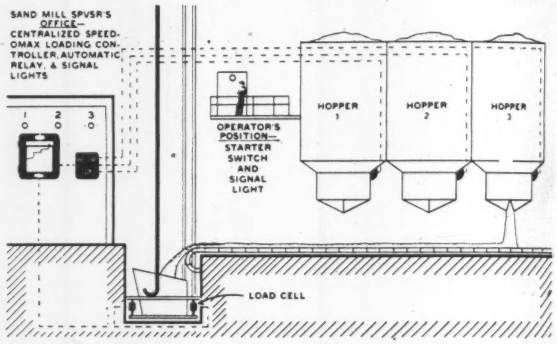
Foundry Sand Automatically Mixed and Batched

GRANITE CITY, Illinois.—General Steel Castings Co. makes big castings. Good molds depend on accurate sand batch proportioning—proper blending of different types of foundry sand, plus addition of the correct amounts of binder.

The foundry had tried various methods for proportioning sand from the overhead storage hoppers—but with limited success. A vibratory feeder and stop watch were used. Next, a mechanical scale was tried, but it did not stand up under rough handling. Neither of these methods gave the sand-mill supervisor control over the quality of the mix.

A "Speedomax" automatic controller with Baldwin electric load cells has eliminated guesswork in batch proportioning and solved the problem. Now General Steel Castings can easily tell what weight of sand is measured out of each hopper, the total weight of the batch, and how many batches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1 2 3
OPERATOR'S POSITION— STARTER SWITCH AND SIGNAL LIGHT
HOPPER 1
HOPPER 2
HOPPER 3
LOAD CELL

are proportioned per day. The foundry's records prove they are now mixing 35 percent more sand per 8-hour day than by previous methods. And each mixture is now controlled to within 20 lbs.—about 1 percent. Not only can the foundry eliminate guesswork and duplicate best results, but the sand mill supervisor always has complete control.

The elements which respond to sand weight are four "SR4" tension cells, installed at the corners of the platforms supporting the collecting bucket. One end of each cell is mounted to the platform by a hickory shear pin. Should the bucket give way while in a raised position, the pins would protect the cells.

The four cells feed an electrical signal equivalent to weight to the "Speedomax" controller in the supervisor's office. On the panel beside the "Speedomax" is a separate instrument with three control dials, one representing each sand hopper. The instruments are calibrated from 0 to 3000 lbs. in 20-lb. increments. All the supervisor has to do, therefore, is set the dials for the precise proportions he desires in the batch. The instruments do the rest.

When the operator at the loading bucket pushes a button, the controller automatically opens and closes the sand-hopper gates, weighs out the prescribed proportions, and continuously indicates and records the weight of each type of sand as it is collected in the bucket. From hopper to hopper, the weighing operation proceeds according to plan.

Red, green, and yellow lights on the instrument panel tell the supervisor which hopper is pouring sand at the moment. On the line, a white light signals the operator when the program is complete.

The whole system is interlocked so that the collecting bucket can be raised only upon completion of the program. Should sand supply in any one hopper be insufficient to complete the program, the operator cannot hoist the bucket. If more than 20 lbs. of sand from the previous mix remains in the bucket, the program will not begin.

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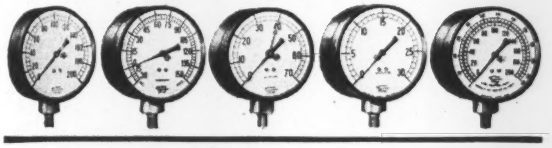

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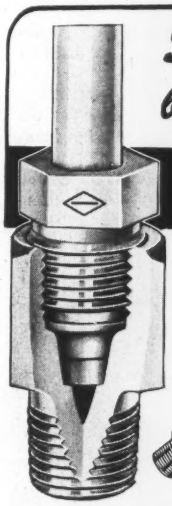

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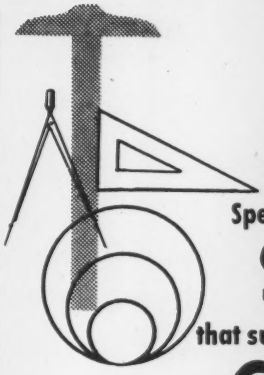

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BRITISH CONTROL CONFERENCE

Continued from page 1173

veloped* since the papers were written, which is unique in possessing no interaction between its actions. This removes one of the arguments in favor of electrical controllers, which of course were the subject of considerable discussion in comparison with pneumatic equipment.

Steady-state Characteristics of Plant

Although all the other papers were concerned with the dynamic characteristics of control systems, Marcy & Yachter emphasized the importance of the steady-state behavior. The paper was based on work outside the process field and unfortunately of a secret nature, so that no details could be given to illustrate the authors' argument. It is a paper, therefore, which must be interpreted in the light of personal experience, from which the gaps for illustrative examples can be filled in.

A theoretical analysis is given of the effect of disturbance (of long period) and of measuring and control unit imperfections on the deviations of controlled conditions in a multi-loop system from their desired values. The total deviations resulting from both causes is expressed in terms of the sum of the contributions of each cause. The optimum choice of system can thus be made if sufficient experimental data are available for determining the steady-state behavior of the system as a whole.

The theoretical analysis thus underlines once more the necessity of obtaining more data on plant characteristics. Perhaps the most important aspect of the paper, from the practical point of view, is that it draws attention again to what could be achieved if adequate data were available, and it does valuable service by emphasising two other very practical points. First, the necessity of making the best choice of measurement and location of measuring point in the loop. Secondly, the difficulties which are introduced by indirect measurement for monitoring product quality. The latter point is a challenge to those chiefly interested in the development of measuring units.

Measuring and Transmission Lags

The papers in the second category, by A. R. Aikman[11] and Wilfred H. Howe[12] dealt chiefly with the effects of lags in the detecting element of a flowmeter and of lags in transmitting control signals to the flow control valve.

Aikman's paper was confined to theoretical analysis, whereas Howe's paper gave considerable experimental data. These included the results obtained with a rapid-response detecting element†, with some emphasis on the

*Developed by Messrs. Negretti & Ltd., London, England.

†Developed by The Foxboro Co., U.S.A.

comparatively high-frequency (a few cycles/second) "noise" associated with flow measurement. The method claimed to overcome the "noise" problem involved the use of integral action times shorter than normal and a wider proportional band.

Aikman gave the results of analyzing several theoretical plants with characteristics representative of those which might be found in practice, and drew conclusions relating to the precise effect of any measuring or transmission lag in a given system.

The significance of these two papers is that a theory adapted for ready application and an increasing amount of experimental data, are now available for studying the complete "closed loop." A great deal is now known about detecting elements, controllers, measuring and transmission lags, and regulating units. It remains to find out the characteristics of plant elements so that the synthesizing techniques employed by servo engineers can be applied with their full power.

Apart from the immediate practical application of the information in these two papers, they must act as a spur to the collection of data on plant characteristics. They must therefore be regarded as making an important step towards rational design of plant for automatic control.

Discontinuous Control Systems

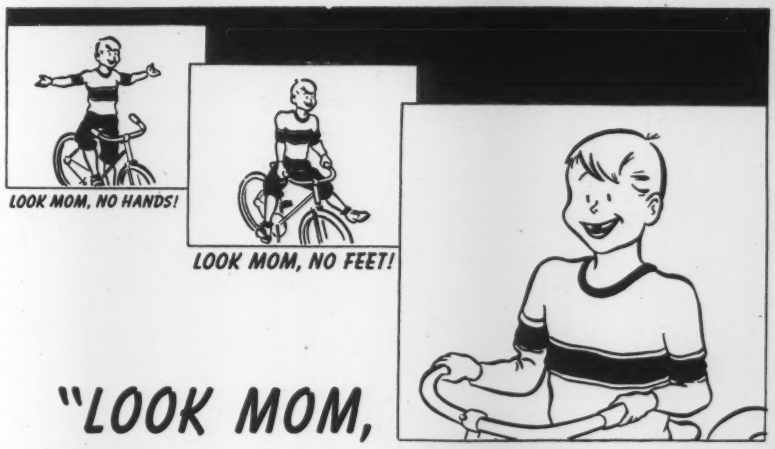
A great deal could be written about the three papers presented by the German authors H. Sartorious,[13] R. C. Oldenburg[14] and W. Oppelt,[15] but they are all highly mathematical analyses, which would require far more space to interpret than is available. The first two papers were written to be complementary and between them present a theoretical analysis of discontinuous proportional control. In the third paper, Oppelt discusses various types of feedback in discontinuous control systems.

The importance of the papers by Sartorius and Oldenburg is that they show that circumstances can arise in which discontinuous control gives advantages over continuous control. Further, that in certain conditions an additional lag, purposely introduced into the system, can improve the performance of a discontinuous control system.

It is not anticipated that these papers will be of any considerable practical value immediately. They are important because they have laid a solid foundation upon which to base further work on discontinuous systems. From an economic point of view, the lower initial cost and greater simplicity of equipment for discontinuous control cannot be ignored. It is probably on account of the greater difficulties which arise in considering discontinuous control systems, that their analysis and development have been to a large extent neglected up to the present time.

Conclusion

The conference provided a valuable opportunity for interchange of results



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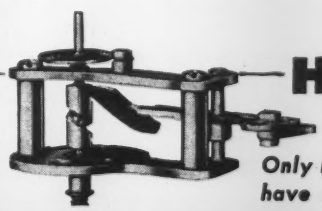

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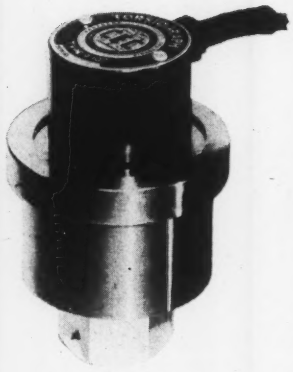
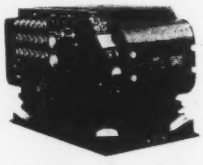


The Consolidated 9-102 Torsiograph accurately measures frequency and amplitude over a vibration range of 10 to 1000 cycles-per-second.

Torsional vibration—the alternating instantaneous variations from uniform rotational shaft speed—seriously affects the efficiency and life of any machine having high-speed rotating parts. To eliminate these destructive forces, their frequency and amplitude must first be measured accurately.



CEC 5-114
RECORDING OSCILLOGRAPH

Consolidated's 9-102 Torsiograph provides these answers when attached by means of its locking collect to the shaft under test. When the shaft deviates from its average speed, the Torsiograph generates a minute current proportional to the instantaneous velocity of the deviation.

Measurement of the torsional vibration may then be made by running the output voltage of the Torsiograph through a vibration meter such as Consolidated's direct reading type 1-110B. For study of the wave form of the vibration, the output voltage may be fed into an oscilloscope or recording oscillograph such as Consolidated's 5-114.

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TORSIOGRAPH

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Analytical Instruments
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CEC

for Science and Industry
Pasadena 8, California

and experience and the papers were of a very high standard. It must automatically succeed in its first objective therefore. At the same time it can only *initiate* advances in the field of education (in its widest sense) and in collaboration between the various groups concerned. Therefore it must be followed up by some hard thinking on these matters by individuals in the various groups, discussions to obtain general agreement on the steps to be taken in the circumstances of local and national needs and finally, action to obtain the desired ends.

The purpose of this article will have been achieved if it draws the attention of some readers, who were not at the Conference, to these matters and initiates some further thought about them.

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(12) *A Consideration of Process-control Servomechanisms. W. H. Howe (Foxboro Company, U.S.A.).

(13) *Theory of Error-activated Step Regulators. H Sartorius (Munich, Germany).

(14) *Application and Further Development of Error-activated Step Regulators. R. C. Oldenbourg (Munich, Germany).

(15) *Approximate Calculation in Continuous and Non-continuous Control Processes. W. Oppelt (Hartman & Braun A.G., Frankfurt-Main, Germany).

*Papers read at Conference.

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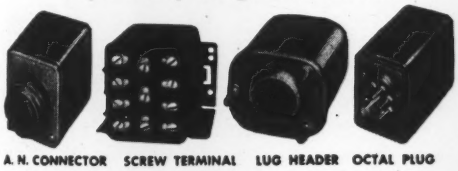

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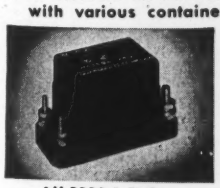
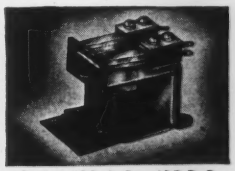


AN-3320-1 D.C.

AN-3324-1 D.C.

Series 595 D.C.



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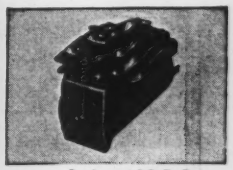

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NOTHING else can do what Microcarb does in controlling the carburization of steel parts. Gears, shafts, cams, bearings and all the other items which owe some of their high quality and low cost to the carburizing process can now be made even better—and possibly at even lower cost.

The cause of such improvement is simply that Microcarb measures directly the carburizing "strength" of the furnace gases which supply carbon to the work being processed.

Heretofore many carburizing equipments have measured the amount of carbonaceous material fed into the furnace, but none has **directly** measured the active carbon in the hot furnace gas. For a comparison, think of heating your home by putting fuel in the furnace, without a thermometer to tell the temperature. Keeping your home at the same temperature day in and day out would then be an art rather than a science; some one person's judgment would have to be accepted, but there'd be no check. The comparable condition has heretofore been quite common in carburizing operations, everywhere.

Microcarb ends that uncertainty; it measures and controls carbon directly. Heat-treaters simply set the Microcarb Controller at 90 if they wish to carburize to ninety carbon. "The carbon you set is the carbon you get".

The "reason why" for Microcarb is its carbon detecting element. This invention, called a Carbohm, is an engineering rarity—a truly new device for sensing a change in its surroundings.

Basically, a Carbohm is a wire, made of an alloy which will either absorb carbon from the furnace atmosphere, or lose it to the atmosphere, until it and the atmosphere are in equilibrium, carbon-wise.

With every change in the wire's carbon content, there's a corresponding change in its electrical resistance. The two Microcarb instruments — Controller and Carbon Recorder—translate this resistance directly into terms of percent carbon, control on that basis and record the result.

Only Homocarb carburizing equipment of our new Series H can be used with Microcarb, because the furnace and its temperature control must be designed to meet the needs of atmosphere regulation. Specific features are a soundly designed electric furnace with solid-bottom retort, improved fan housing and work support, and aerodynamically designed discharge jets. Micromax temperature control of the Duration-Adjusting Type is included.

Microcarb is many things to many men, especially in defense work.

To top management, Microcarb means better competitive position (for the individual company) quality-wise and possibly cost-wise. Also, it meets the usual desire for process control which is fully automatic.

To production executives, Microcarb means closer following of production schedules, because carburizing speeds and results are definitely more predictable than ever before.

To personnel executives, Microcarb means cleaner, more attractive working conditions. And, if the heat-treat uses incentive pay, Microcarb helps heat-treaters increase their earnings, because it makes it easier for them to apply their skill and therefore increase their productivity.

To metallurgists, Microcarb means some or all of the above advantages, plus a tightening of technique such as every technician likes. "New" or hard-to-handle steels hold fewer puzzles. Standard steels emerge with closer specifications. The heat-treat takes another long step toward becoming a manufacturing laboratory.

Let us send you further facts about this new Microcarb Control. Ask our nearest office, or 4955 Stenton Ave., Phila. 44, Pa.

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Volume 7 October 1951 Number 10

Journal

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THE SECRETARY'S PAGE

Richard Rimbach

THE message from your secretary must of necessity be brief this month due to his returning from the Houston Meeting with two weeks work piled up on his desk.

The secretary's report as made to the Board of Directors is quoted here:

• • •

Society Membership:

The membership of the Society now numbers 4549. This is a decrease of 8 members over the count made in March 1951. Table 1 shows a breakdown of the Society membership by Section affiliation and grade of membership as of September 1, 1951. Four deaths have been reported to the National Office, that of Mr. B. F. Heye of 305 Texas St., Corpus Christi, Texas, member of the South Texas Section; Mr. C. B. Ivester of Dumas, Texas, member of the Panhandle Section; Mr. George M. Pohler of 3520 Mary Anne Lane, Cincinnati 13, Ohio, member of the Cincinnati Section; Mr. D. E. Campbell of 412 Kenna Ave., So. Charleston, W. Va. member of the Charleston Section.

New ISA Section:

The newest group to be granted a charter is the Denver Section, ISA. This Section was granted a charter on July 27, 1951. Sections of the Society now number 52.

Visits of Secretary to Local Sections:

Since the September 1950 Annual Meeting, the Secretary has attended the following Section Meetings, aside from the ISA National Executive Committee Meetings:

Oct. 8-14, 1950 Houston Committee on Instrument Conference & Exhibit
Nov. 2, 1950 Philadelphia Section Meeting
Nov. 27, 1950 New York Section Meeting
Dec. 27, 1950 Cleveland Committee on Instrument Conference and Exhibit
Jan. 15, 1951 Washington Section Meeting
Jan. 26-27, 1951 New York Regional Conference Meeting
Jan. 28-Feb. 2, 1951 Houston Committee, ISA Conference
Mar. 28-30, 1951 Pittsburgh Regional Meeting
Apr. 2, 1951 Philadelphia Regional Meeting
Apr. 3, 1951 New Jersey Regional Meeting

Apr. 9, 1951 Chicago Section Meeting
May 21, 1951 Talked before New York Section Meeting
June 5-7, 1951 Houston Committee ISA Conference
Aug. 8-11, 1951 Houston Committee ISA Conference

Film on Control Principles by G. F. Akins and J. H. Kowalski:

The film "Principles of Automatic Control" has been shown since October 5, 1950 to date, at approximately 143 different showings. Results of a questionnaire show an average of 90 at a showing. This means that about 12,000 persons have viewed the film to date. About 80 requests for scheduling the film are on hand now. Three copies of the film are in circulation. Eight copies of the film have been sold.

Houston Exhibit:

200 booths have been sold to exhibitors, 5 have been given to co-sponsoring societies, 12 have been allocated to Government agencies and 2 have been allocated to educational institutions.

Co-sponsoring Societies of the Conference and Exhibit are:

American Society of Mechanical Engineers, Industrial Instruments and Regulators Division;
American Institute of Physics;
American Institute of Electrical Engineers, Instruments and Measurements Committee;
Institute of Radio Engineers;
National Association of Corrosion Engineers;
Gulf Coast Spectroscopic Group;
The PipeLiners Club;
A & M College of Texas Symposium on Instrumentation for the Process Industries;
Research and Development Board and the National Bureau of Standards Infrared Instrumentation Symposium.

• • •

Due to the increased load in the National Office, the Executive Committee has employed a Society Manager beginning with September 1st. For members who did not have the pleasure of meeting the Society Manager, Mr. Percy Jones, at Houston, this page will serve as an introduction.

Mr. Jones' duties have been outlined by President McMahon as follows:

1. Maintain and staff a business office for the Society.
2. Maintain membership records.
3. Handle in conjunction with the Treasurer all receipts and disbursements of Society funds.
4. Maintain financial records of the Society.
5. Record the proceedings and actions of the Board of Directors and of the Executive Committee.
6. Make all business arrangements for, and all details of, the Annual Conference, in collaboration with the Exhibit Manager and the Meetings Committee.
7. Act as publisher of the ISA Journal.
8. Arrange for printing of materials submitted by the Publications Committee.
9. Arrange for typing, duplicating and mailing of Society Committee reports and notices when requested.
10. Publicize the Society's activities.

This is quite a job to have thrust upon him and I ask all of the members to be patient during the change-over period.

Unfortunately, I must announce the resignation of Mr. John McCaffery who has served you so faithfully during the last 3 years. Mac is leaving October 5th.

Table 2. Increase of Membership

DATE	TOTAL MEMBERS	NUMBER OF SECTIONS
8/46	1075	21
12/46	1650	23
4/47	2121	27
8/47	2296	32
3/48	2966	38
8/48	3280	41
3/49	3762	44
5/49	3908	44
9/49	3880	47
1/50	4224	49
6/50	4300	52
9/50	4298	52
9/51	4549	52

Table 1. Membership of Sections, Sept. 1, 1951

SECTION	M	AM	SM	TOTAL
Akron	30			30
Albuquerque	32	14		46
Aruba	41			41
Atlanta	23	1		24
Baltimore	77	4		81
Baton Rouge	23			23
Boston	121			121
California	174			174
Central Illinois	32	1		33
Central Indiana	25	50	2	77
Central New York	31			31
Charleston	61	4		65
Chicago	223	20	78	321
China Lake	23	1		24
Cincinnati	66			66
Cleveland	117	4	1	122
Columbus	17	4	1	22
Cumberland	18	2		20
Denver	51			51
Detroit	58	1		59
Eastern New York	62	1	24	87
Gulf Coast	32	2		34
Houston	145	2		147
Kansas City	57	17		74
Louisville	38	5	2	45
Montreal	76		1	77
New Jersey	279	1		280
New Orleans	9			9
New York	200	12	49	261
Niagara Frontier	75	18	6	99
North Texas	12	1		13
Northern California	94			94
Northern Indiana	41	3	1	45
Oak Ridge	76			76
Ontario	43	1		44
Panhandle	39			39
Philadelphia	315	15	9	339
Pittsburgh	223		15	238
Presque Isle	19	1		20
Richland	81	13	13	107
Rochester	87		1	88
Sarnia	77	8		85
South Michigan	18	8	1	27
South Texas	46	8	15	69
St. Louis	110	2	2	114
Tennessee	32	17	1	50
Toledo	41	1		42
Tulsa	105	1	1	107
Twin Cities	31	10	2	43
Washington	73	61		134
Wayne County	62	26	1	89
Wilmington	88	2		90
At Large	46	4	2	52
	3975	346	228	4549

SECTION	CHARTER DATE	8/47	8/48	9/49	9/50	9/51
Akron	7/19/48		14	43	36	30
Albuquerque	7/16/49				59	46
Aruba	1/20/47	28	64	59	39	41
Atlanta	8/23/48		16	20	17	24
Baltimore	1/10/46	60	63	69	76	81
Baton Rouge	5/10/49				47	23
Boston	7/28/48			86	105	121
California	1/10/46	47	103	164	167	174
Central Illinois	3/ 8/48		26	30	36	33
Central Indiana	1/30/47	81	82	78	80	77
Central New York	5/15/50				18	31
Charleston	1/10/46	91	80	81	68	65
Chicago	1/10/46	245	270	299	342	321
China Lake	1/17/49			86	41	24
Cincinnati	3/ 7/47	43	58	65	62	66
Cleveland	1/10/46	119	127	122	129	122
Columbus	7/16/49				26	22
Cumberland	4/24/46	31	19	15	14	20
Denver	7/27/51					51
Detroit	1/10/46	83	79	75	65	59
Eastern New York	1/20/47		58	90	98	87
Gulf Coast	1/10/46	28	46	42	41	34
Houston	3/16/48		82	113	134	147
Kansas City	1/10/46	38	49	53	57	74
Louisville	3/ 7/47	53	38	39	37	45
Montreal	6/16/48		38	72	82	77
New Jersey	1/10/46	146	189	227	232	280
New Orleans	4/11/46	9	9	4	10	9
New York	1/10/46	132	150	214	250	261
Niagara Frontier	7/31/47	48	120	90	91	99
North Texas	2/16/49			40	24	13
Northern California	9/10/49				102	94
Northern Indiana	1/10/46	21	28	23	26	45
Oak Ridge	8/27/46	69	55	67	66	76
Ontario	1/10/46	61	39	43	41	44
Panhandle	2/10/50				45	39
Philadelphia	1/10/46	263	328	381	330	339
Pittsburgh	1/10/46	157	185	219	241	238
Presque Isle	7/31/47	2	24	22	18	20
Richland	1/ 1/48		124	99	72	107
Rochester	2/16/48		60	67	77	88
Sarnia	9/ 1/47		99	77	77	85
South Michigan	11/11/46	51	45	34	26	27
South Texas	11/11/46	50	42	46	61	69
St. Louis	1/10/46	79	82	112	132	114
Tennessee	1/10/46	23	40	41	46	50
Tulsa	9/ 6/47		75	82	96	107
Toledo	4/15/50				27	42
Twin Cities	3/10/47	11	46	44	36	43
Washington	1/10/46	141	134	143	116	134
Wayne County	1/10/46	41	42	45	73	89
Wilmington	12/ 2/49				77	90
At Large				27	28	52
TOTAL MEMBERS		2296	3280	3880	4298	4549

Section Secretaries, Meeting Data and Programs

AKRON
Fred Appel, 932 Columbia Ct., Barberton, Ohio. Tel: SH 3440
Fourth Tuesday, 7:30 P. M., Akron Y.W.C.A.

ALBUQUERQUE
W. E. Bostwick, 2615 Sandia Dr., Bel Air, Albuquerque, N. Mex.
First Monday, Meeting at 8:00 P.M., Science Lecture Hall, Univ. of N. M.

ARUBA
E. H. Pfeffer, P.O. Box 291, c/o Lago Oil & Transport Co., Ltd., Aruba, N.W.I.
First Tuesday, 7:30 P. M., Engr's Club.
Nov. 15-17. Caribbean Instrumentation Conference. Subjects: Tank Gaging, Flow Plan Symbols, Conductivity, Viscosity Measurements, Instrument Training, Water Treatment, Graphic Panels, and Electronics.
Nov. 17. Annual Meeting.

ATLANTA
D. M. McRae, 150 Nassau St., Atlanta, Ga.
Fourth Monday, Meeting at 7:45 P.M., Ga. Institute of Technology.

BALTIMORE
G. B. Greer, 631 East 36th St., Baltimore 18, Md. Tel: CHesapeake 6879
Second Friday, Meeting at 8:00 P.M., Engr's. Club of Baltimore.

BATON ROUGE
John Q. Bass, 1517 Longwood Dr., Baton Rouge, La. Tel: 3-0283
Meeting monthly, L.S.U. Physics Bldg.

BOSTON
Stephen E. Lord, 60 Braintree Ave., Quincy 69, Mass. Tel: MA 9-1066
Last Wednesday, Dinner at 6:30 P. M., Meeting at 7:00 P.M., 99 Club, 99 State St.

CALIFORNIA
D. C. Duncan, Helipot Corp., 916 Meridian Ave., S. Pasadena, Calif. Tel: SY 4-8439
Second Wednesday, Dinner at 6:30 P. M. Meeting at 8:00 P.M., Carolina Dines.

CENTRAL ILLINOIS
H. R. Getz, 723 Laura Ave., Peoria 5, Ill. Tel: 4-2800
First Wednesday, Dinner at 6:30 P.M., Meeting at 7:30 P.M.

CENTRAL INDIANA
Richard F. Rieman, 3550 Euclid St., Indianapolis, Ind. Tel. CH 7462
First Tuesday, Meeting at 7:30 P. M.

CENTRAL NEW YORK
Karl W. Robertson, Minneapolis-Honeywell Reg. Co., 121 Onondaga St., Syracuse.

CHARLESTON
Fred Gilmer, 418 Beech Ave., Charleston, W. Va.
First Monday, Dinner at 6:15 P.M., Meeting at 8:00 P.M., Kanawha Hotel.

CHICAGO
Floyd E. Ertsman, Rm. 1490 Fisher Bldg., 343 S. Dearborn St., Chicago 4, Ill. Tel: WE 9-0686
First Monday, Dinner at 6:30 P. M., Meeting at 8:00 P. M., Shoreland Hotel.

CHINA LAKE
A. H. Staud, 1004 Michelson Lab., USNOTS, China Lake, Calif. Tel: 77882
Fourth Thursday, Meeting at 8:00 P.M., Michelson Lab, USNOTS.

CINCINNATI
R. J. Eichner, 1900 Courtland Ave., Norwood 12, Ohio. Tel: Jefferson 3130
Second Monday, Dinner at 6:30 P.M., Eng'r. Society Hqs.

CLEVELAND
G. D. Karnegie, 3436 Lorain Ave., Cleveland, Ohio.
Fourth Wednesday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Cleveland Eng'r. Society, E. 19th St.

COLUMBUS
E. M. Chandler, 91 E. Como Ave., Columbus 2, Ohio. Tel: JE 9994.
Third Thursday, Meeting at 8:00 P.M., Battelle Auditorium

CUMBERLAND
Clyde Babst, 225 Cecilia St., Cumberland, Md. Tel: 583-W
Tuesday after Fourth Monday, 8:00 P. M., Dinner at 6:30 P. M., Algonquin Hotel.

DENVER
G. M. Peters, 3191 W. Denver Place, Denver 11, Colo. Tel: GRand 9073

DETROIT
A. W. Brueckner, 5556 S. Clarendon Ave., Detroit 4, Mich. Tel: TYler 6-9511.
Third Tuesday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., Rackham Bldg.
Nov. 19. Magnetic Tape Recording of Sound and Telemetered Data.

EASTERN NEW YORK
W. R. McKegg, c/o Gen. Engrg. & Consulting Lab., G. E. Co., Schenectady, N. Y.
First Tuesday, 8:00 P.M., Dinner at 6:30 P.M.

GULF COAST
W. N. Sloan, E. I. Du Pont de Nemours & Co., Orange, Texas. Tel: 8411 Ext. 444
Third Tuesday. Meeting at 7:30 P.M., Lamar College, Beaumont, Texas.

HOUSTON
I. K. Farley, Brown Instrument Co., 2123 Travis St., Houston, Texas, Tel: Charter 2511.
Last Monday, 8:00 P. M., University of Houston.

KANSAS CITY
H. H. Schmall, 3706 Benton Blvd., Kansas City 3, Mo. Tel: AR 4808
First Tuesday, 7:30 P.M., U. of Kansas City.

LOUISVILLE
C. M. Bosworth, 203 Arbor Park, N., Lo., Ky.
Fourth Tuesday, Meeting at 8:00 P.M., Seagram Auditorium.

MONTREAL
L. E. Henne, Bristol Co. of Canada Ltd., Dominion Square Bldg., Montreal, Quebec, Can. Tel: UNiversity 6-4725.
Last Monday, 8:00 P. M., Mechanics' Institute.

NEW JERSEY
L. H. Ballinger, 2371 Channing Ave., Westfield, N. J. Tel: Westfield 2-0765M
First Tuesday. Meeting at 8:00 P.M., Essex House, Newark.

NEW ORLEANS
W. H. Haney, 2927 Music St., N. O. 22, La.
No Regular Date, Meeting at 8:00 P.M.

NEW YORK
F. B. Leslie, 8856 Commonwealth Blvd., Bellerose 6, N. Y. Tel: FI 7-0645
Last Monday, Dinner at 6:00 P.M., Meeting at 7:45 P. M., Hob Nob Club, 108 E. 41st St.

NIAGARA FRONTIER
Mrs. James L. Martin, 34 Manning Rd., Eggertsville 21, N. Y. Tel: WIndsor 0087
Fourth Monday, Dinner at 6:30 P.M., Meeting at 8:00 P.M., N. Y. State Inst. of Arts and Sciences, Buffalo.

NORTH TEXAS
R. E. Byers, 6000 Lemmon Ave., Dallas 9.

NORTHERN CALIFORNIA
Bert L. Anderson, 1951 47th Ave., San Francisco, Calif. Tel: SEabright 1-5030
Third Monday, Dinner 6:30 P. M., Meeting 8:00 P. M., Spengers Grotto.

NORTHERN INDIANA
J. Baum Beckman, 547 N. Waller Ave., Chicago 44, Ill. Tel: ES 8-7776
Second Tuesday, Meeting at 7:30 P.M., Whiting Community Center, Whiting, Ind.

OAK RIDGE
J. Lundholm, Jr., Eff. A-3, Apt. 214, Oak Ridge, Tenn. Tel: 5-6539
First Wednesday, Meeting at 7:30 P.M., Knight's of Columbus Hall.

ONTARIO
John W. Huether, 311 Southerland Dr., Leaside, Ontario, Canada. Tel: HU-7114
Third Thursday, Meeting at 8:00 P.M. Friendship Hall, College St. United Church, Toronto

PANHANDLE
W. F. Hoag, Phillips Chem. Co., Box 277, Dumas, Texas. Tel: 241.
Third Tuesday, Meeting at 8:00 P.M.

PHILADELPHIA
R. A. Trenner, Energy Control Co. Rm. 306, 3147 N. Broad St., Philadelphia 32, Pa. Tel: SA 2-7900
Third Wednesday, Meeting at 8:00 P.M., Bellvue Stratford Hotel.

PITTSBURGH
W. C. Langerman, Fisher Scientific Co., 711 Forbes St., Pittsburgh 19, Pa. Tel. Express 1-1330.
Fourth Monday, meeting jointly with the Technical Committee on Inspection and Gaging. Dinner at 6:30 P.M., Meetings at 8:00 P.M., Roosevelt Hotel.

PRESQUE ISLE
Edwin P. Schuwerk, 445½ Halley St., L. P., Erie, Pa. Tel: 2-3349
Fourth Tuesday, Meeting at 8:00 P.M., G. E. Community Center, East Lake Rd., Erie, Pa.

RICHLAND
T. H. Quinn, 1513 Goethals Dr., Richland, Wash.
Second Wednesday, Meeting at 7:30 P.M., American Legion Hall.

ROCHESTER
R. C. Schwarz, Jr., 1201 Granite Bldg., Rochester 4, N. Y. Tel: Monroe 4610R
Fourth Tuesday, Meeting at 8:00 P.M., Univ. of Rochester, Physics Lecture Hall.

SARNIA
L. J. Hall, 730 Talfourd St., Sarnia, Ont., Canada. Tel: EDgewater 2258.
Second Friday, 8:00 P. M., Moose Hall.

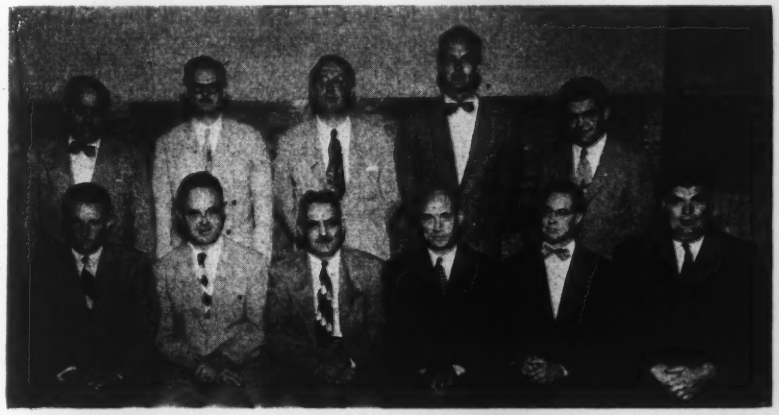
SOUTH MICHIGAN
W. J. Sprau, 2509 S. Rose St., Kalamazoo, Mich. Tel: 4-7012.
Fourth Wednesday, 8:00 P. M., Dinner at 6:30 P. M., Chicken Charlie's, Kalamazoo.

SOUTH TEXAS
H. C. Givens, La Gloria Corp., P.O. 637, Falfurrias, Texas. Tel: 122-W
First Wednesday. Meeting at 7:30 P.M.

ST. LOUIS
W. G. Lee, 4710 Delor St., St. Louis 16, Mo. Tel: FL 8516.
First Wednesday, Meeting at 8:00 P.M., Engineer's Club of St. Louis.

Continued on page 1224

National Officers



Front row left to right—G. R. Feeley, Treasurer; R. T. Sheen, incoming V.P., General Relations Div.; J. B. McMahon, outgoing President; Dr. A. O. Beckman, President elect; W. A. Wildhack, 1st V.P.; N. L. Isenhour, V.P., Operating Division.

Back row left to right—R. Rimbach, Executive Secretary; P. V. Jones, Jr., Society Manager; P. Hart, outgoing V.P.; N. Gildersleeve, outgoing V.P.; D. M. Boyd Jr., incoming V.P.

SECTION SECRETARIES, MEETING DATA & PROGRAMS

Continued from page 1223

TOLEDO
P. H. Girkins, 418 Waggoner Blvd., Toledo 12, Ohio. Tel: LA 6505
Third Tuesday, Meeting at 8:00 P. M., Service Bldg., Toledo Edison Co.

TENNESSEE
N. M. Taylor, 16 Edgewood, Kingsport, Tenn. Tel: 3338J
No definite night, Dinner at 6:45 P.M., Meeting at 8:00 P.M., Hall's Dining Rm., Bristol Hwy., Kingsport.

TULSA
S. M. Bagwell, 1544 E. 35th Pl., Tulsa 5, Okla. Tel: 7-6822
First Monday, Meeting at 7:30 P.M., Engineering Bldg., Tulsa Univ.

TWIN CITIES
Alden Hine, c/o Pinkney & Hine, 552 Plymouth Bldg., Minneapolis 3, Minn. Tel.: Lincoln 0523.
Fourth Tuesday, Dinner at 6:30 P.M. Coffman Memorial Union, U. of Minn.

WASHINGTON
Raymond E. Miller, 20-224 Naval Ord. Lab., White Oak, Md. Tel: JU 7-6742
Third Monday, Meeting at 8:00 P.M., P. E. P. Co. Auditorium.

WAYNE COUNTY
J. R. McCauley, 18073 Archdale, Detroit 19, Mich. Tel: KE 1-5239.
Third Monday, Meeting at 8:00 P.M., Larson's Cafe, Lincoln Park, Mich.

WILMINGTON
J. E. Charsha, Jr., Hammel-Dahl Co., 1000 Washington St., Wilmington 11, Del. Tel: 2-6694
Third Tuesday, Meeting at 8:00 P.M. Harlan Public School, Wilm.

ISA EMPLOYMENT SERVICE

Forward your letter to INSTRUMENT SOCIETY OF AMERICA
921 *Ridge Ave., Pittsburgh* 12, *Pa.*

The following open positions were posted at the Employment Register, Sixth National Instrument Conference and Exhibit, Houston, Texas, and are listed here for the benefit of those who did not attend the Conference and Exhibit and who may be interested in making application. All of the positions listed were still open at the close of the Conference and Exhibit.

INSTRUMENT ENGINEERS. Graduate Mechanical, Electrical or Chemical, with several years industrial instrumentation experience for positions as Project Engineer handling design, purchase, and engineering on prefabricated process control panels. Unusual opportunity for men able to work on several projects and meet schedules. Interesting work with manufacturer of quality equipment. Location, Chicago, Ill. or Wilmington, Del. All replies confidential. Box 522.

INSTRUMENT ENGINEERS. Graduates with 5 or more years of engineering and/or maintenance experience in industrial instrumentation. Location General Electric, Richland, Washington. Box 523.

INSTRUMENT ENGINEER. Experienced in product development of medium and small precision clock mechanisms. Permanent position for right man. Write stating age, experience, and salary expectations. Location Connecticut. Box 524.

INSTRUMENT ENGINEERS. Experienced only. General instruments for gas process work. Location Girdler Corp., Louisville, Ky. Box 525.

INSTRUMENT ENGINEER. Minimum 10 years experience repairing major makes and types of industrial controls, instruments and valves, plus minimum 2 years supervisory experience, including cost records and reports. Essentially able to coordinate and administer all repair shop operations, also perform and work for demonstration and training purposes. Group insurance and pension benefit plan in operation. Good salary and permanency for right man. Location Detroit, Mich. Box 526.

INSTRUMENT ENGINEER. Electrical Engineer experienced in electrical and mechanical design of motor-driven timing devices. Permanent position for right man. Write stating age, experience, and salary expectations. Location Connecticut. Box 527.

INSTRUMENT ENGINEER. To assist in design and layout of recording and controlling instruments and panels on pressure, temperature, flow, liquid-level, etc., for extensive applications in large new chemical plant. Work location Montreal, Canada. Later transfer to plant-site in vicinity of Brockville, Ontario, Canada, on maintenance and development work may be arranged. Two to five years' experience with various types and makes of instruments required and some supervisory experience desirable. Applications should include resume of personal background, education and experience, and will be treated in strict confidence. Box 528.

INSTRUMENT ENGINEERS. Needed immediately for Flight Test Instrumentation. Servomechanisms, Electronic Design by large aircraft Manufacturer. Starting rate and future advancement commensurate with ability, experience and background. Excellent working conditions and liberal employee benefits, a future with a progressive company. Send resume of training and experiences. Location St. Louis 3, Mo. Box 529.

INSTRUMENT ENGINEERS. With experience in application, selection, installation and maintenance of measurement and automatic control equipment in wide variety of chemical processes. Must travel to plant locations for start up assistance, diagnosis of plant instrumentation problems and training of plant instrument forces. Working knowledge of process control theory as applied to pneumatic systems is desirable. Give education, experience and salary desired in first letter. Location Wilmington, Del. Box 530.

INSTRUMENT ENGINEER. E. I. du Pont de-Nemours Engineering Dept. needs experienced instrument engineers familiar with the application of process control instrumentation to wide variety at chemical processes. Must be willing to travel from Wilmington, Delaware headquarters to plant locations for consultation on measurement and control problems. Practical familiarity with process control theory and with analysis apparatus is desirable. Box 531.

INSTRUMENT ENGINEERS. Instrument Department now being formed for Atomic Energy Commission plant at Aiken, S. C. Requirement cover fields of industrial process instrumentation, radiation instruments, electronics and servomechanisms. Plant to be operated by E. I. du-Pont de Nemours & Co. Box 532.

INSTRUMENT ENGINEER. Electro-chemicals plant producing metallic sodium and chlorine gas requires engineer able to maintain as well as supervise the Instrument Department including instrument mechanics and helpers. Applicant should have extensive industrial experience in instruments. Excellent opportunity. Location Ashtabula, Ohio. Box 533.

INSTRUMENT ENGINEER. With broad background in laboratory instrumentation. Opening in Chemical Research Laboratory for man to do maintenance, design and construction of instruments used in chemical and physical research as well as development of specialized process control instruments. Should have a broad background in fundamentals of instrumentation. Salary commensurate with training and experience. Right man will develop into group leader of Instrumentation Group. Location St. Louis, Mo. Box 534.

INSTRUMENT ENGINEERS. 2 or 3 years experience—pressure sensitive instruments and small precision mechanisms, experimental and preliminary design work, regular products. Excellent working conditions. Resume requested. Location N. J. suburban area. Box 535.

INSTRUMENT ENGINEER. With the minimum of 5 years experience and the application of industrial process instruments for large continuous chemical processes. Work from process chemical specifications to prepare instrument flow sheets, specify equipment and supervise preparation of instrument construction drawings. Work involves originality and ability to supervise other instrument engineers. Employment subject to government clearance. Location New York. Box 536.

INSTRUMENT ENGINEER. Capable instrument man for company of designing engineers and constructors for the petroleum and chemical industries. Location Houston, Texas. Box 537.

DEVELOPMENT ENGINEER. To design and develop a workable instrument, operating from prescribed physical principles. The man required must have a general knowledge of engineering, including some electronics, mechanics, machine shop practice and the ability to undertake the responsibility of a development project. Salary is commensurate with ability and initiative. Location New Jersey. Box 538.

DEVELOPMENT ENGINEER. To design and develop small computing and control electromagnetic devices such as servo motor, synchros, resolvers, induction generators, torque motors, etc. BS in Electrical Engineering plus five years experience in the development of electro magnetic devices. Salary 6000 to 10000. Location Long Island, N. Y. Box 539.

DEVELOPMENT ENGINEER. Electrical Engineer needed for development of electro-mechanical and electronic control equipment. Good understanding of engineering fundamentals required, along with some training in electronics. The man required should have the ability to take over responsibility on complete projects. Plant has profit sharing trust and other employee benefits. Salary commensurate with experience and ability. Location Central Ill. Box 540.

DEVELOPMENT ENGINEER. E. E. graduate with 2 to 4 years of experience and with a working knowledge of electronic instruments for the development of resistance welding machinery. Location Western, N. Y. Box 541.

DEVELOPMENT LIAISON ENGINEER. To serve as coordinator in the design, development and production planning of electro-magnetic rotating components. Knowledge of manufacturing procedure, drafting and organization essential. BS in EE or ME with two to five years experience in related areas. Salary $4000 to $6000. Location Long Island, N. Y. Box 542.

DEVELOPMENT ENGINEERS. Graduate E.E., M.E. and Physicists. Eight required for work in research and development engineering division. Involves theory, model design and product extension work or small electro-mechanical and pneumatic devices. Location Philadelphia, Pa. Box 547.

DEVELOPMENT ENGINEER. M.E. with four years of experience in testing and development of internal combustion engines and associated instruments. Must be able to assume responsibility. Salary $5000 or higher depending on qualifications. Location So. West New York State. Box 548.

DESIGN ENGINEER. Experienced in designing small precision mechanisms. Outline experience and salary expected in first letter. Location Southeastern Pennsylvania. Box 549.

AIRCRAFT INSTRUMENT ENGINEERS. Graduates, experienced in aircraft and electronic instruments and instrumentation. Large aircraft manufacturer. Location Georgia. Box 543.

APPLICATION ENGINEER. Several years experience for instrumentizing chemical and refinery processes. Location Philadelphia, Pa. Box 544.

APPLICATION ENGINEERS. New or recent graduates, mechanical or chemical. Potential for sales work desirable but not essential. Destination, expert in compressor applications, reciprocating or centrifugal-sales engineering. Location Central New York State. Box 545.

CHEMICAL ENGINEER. Graduate chemical engineer not over 25 years of age. To work in Research and Development at South Charleston, W. Va. Pilot plants design and operation, equipment studies and report writing. Box 546.

ELECTRONIC ENGINEERS. For paper manufacturing company located in eastern part of North Carolina, 110 miles south of Norfolk, Va. Box 550.

ELECTRONIC ENGINEERS. For experimental and development work on telemetering applications and micro wave transmission. Location New Mexico. Box 551.

ELECTRONICS ENGINEERS. Experienced Electronic Engineers needed for work on design and development of electronic instruments. Ideal working conditions in large new plant in Southern California. Box 552.

ELECTRICAL TEST ENGINEER. Aircraft Test Laboratory. Graduate Electrical Engineer to set up conduct, and evaluate tests on servomechanisms, strain gauge installation, and similar equipment. Test engineer also will conduct simulated service tests on aircraft instruments. Location Fort Worth, Texas. Box 553.

MEASUREMENTS ENGINEER. (Three) Conducts laboratory tests and measurement studies on precision computer elements at low audio frequencies. Graduate Electrical Engineer with at least five years experience in related areas. Extensive transformer experience desired. Salary $6000 to $8000. Location Long Island, N. Y. Box 544.

MECHANICAL ENGINEERS. Experienced Mechanical Engineers needed for work on design and development of analytical instruments. Ideal working conditions in large new plant in Southern California. Box 555.

OFFICE ENGINEER. Engineering graduate. Applicant should have interest in power plants, particularly boiler plants, and a basic interest in meters and controls. As opening occurs, successful applicant will have opportunity of promotion to sales engineer to cover territory where earnings are around $10000 per year. Company has profit sharing trust and other incentives. Location Chicago, Ill. Box 556.

PERFORMANCE STUDY ENGINEER. To conduct mechanical performance studies (wear, fatigue, function, etc.) on precision mechanical instrument parts such as gears, bearings, etc. BS in Mechanical Engineering, plus five years experience or MS plus 2 years experience. Salary 5500 to 7500. Location Long Island, N. Y. Box 577.

SERVICE ENGINEERS, FIELD. Leading manufacturer of Recording Oscillographs and Electronic Dynamic Measurement Systems needs two Field Service Men for performing checkout, maintenance, repairs, and customer instruction in the field. Must have two years of college or equivalent and a sound understanding of complex electronic circuits and components, as well as mechanical dexterity necessary for handling precision mechanical assemblies. Must be willing to locate in Chicago, New York, or Philadelphia areas and travel within a 500 mile radius. Company-owned car will be furnished. Six to twelve month training at Pasadena, Calif. plant will be given at full salary rate. Box 558.

SERVICE ENGINEER. To service meters and controls in boiler plants of customers of well established sales organizations. Engineering degree not necessary but applicant must have practical knowledge of meter and controls and should be willing to extend his schooling for further proficiency. Permanent position and excellent opportunity for young man wishing to specialize. Company has profit sharing trust and other incentives. Location Chicago, Ill. Box 559.

ENGINEER. Philadelphia manufacturer requires engineering graduate with minimum of 5 years experience in heat treating design and operation of heat treating furnaces. Position involves applying industrial instruments to heat treating operations. Applicant should have an interest in instrumentation and electronics. Reply stating education, experience and personal data. Location Philadelphia, Pa. Box 560.

ENGINEERS. For electrical design, power distribution, lighting, instrumentation (power panel & process), process pressure vessels, air conditioning, machine design by Atlas Engineering Corp., Oak Ridge, Tenn. Box 561.

ENGINEERS. Experienced in thermodynamics, aerodynamics, high speed machinery for work on industrial gas turbines. Location Central New York State. Box 562.

PHYSICIST—ANALYTICAL. Persons interested in analytical applications of: 1. Recording ultra-violet (Cary); 2. Recording infrared (Perkin-Elmer); 3. Emission spectrography (Applied Research, 1.5 meter); 4. X-ray diffraction (North American Philips); 5. General Electric recording spectrophotometer. Location Decatur, Alabama. Box 563.

PHYSICIST, RESEARCH. PH.D or M.S. in Physics, Electricity or Mechanics for oil well instrumentation. Write for details of position. Location Texas. Box 564.

APPLIED CYBERNETICS. Design & Development work in the areas of Computers, Data Reduction Devices, and Automatic Process Controls. Extremely good opportunities for capable engineers, both Mechanical and Electronic, in a rapidly growing company. Location Los Angeles. Box 565.

SPECIFICATIONS WRITER. To assist in the preparation of standard material and process specifications governing the design of precision electro-mechanical devices. College graduate with technical degree preferred. Salary $3600-$4700. Location Brooklyn, N. Y. Box 566.

DRAFTSMEN. Experienced only, general instruments for gas process work. Location Louisville, Ky. Box 567.

INSTRUMENT SALES ENGINEER. Distributor serving Louisiana & South Mississippi looking for experienced Instrument Engineer to handle sale of Indicating, Recording, & Control Instruments and Allied Lines to oil, chemical, and processing industries, and to the general industrial trade. Prefer man with sales experience, about 35 years old, with car. Must locate in or near New Orleans. Salary (dependent on qualification and experience) and expenses. Box 568.

SALES ENGINEER. For Barton, Robinson Orifice, Conoflow products in Houston area. Chemical or Mechanical Engineering Degrees or equivalent experience desirable. Company also fabricates gas measuring instruments. Box 569.

SALES ENGINEERS. For large instrument manufacturer. Definite opportunity for wide selection of field jobs after training at Headquarters in Pittsburgh, Pa. Box 570.

SALES ENGINEER. Knowledge of applied industrial instrumentation for Houston Territory. Car necessary. Salary & Expense. Sales experience. Box 561.

SALES ENGINEER WANTED. Leading manufacturer of Recording Oscillographs and Dynamic Multichannel Recording Systems needs sales engineer, college graduate or equivalent, with at least 2 years engineering or application experience in instrument field. Prefer experience in instrumentation for dynamic measurement of stress, vibration, pressure, etc. Must be willing to live in Chicago, New York, or Washington area and travel within 500-mile radius. Will give one year of training at main plant in Pasadena, California at full salary. Box 562.

SALES ENGINEER. Experienced in Control Equipment, Steam Equipment, Heat Exchange for Houston area. Salary commensurate with ability and experience. Age 25-40. Engineering degree preferable but not required. Box 563.

SALESMAN. Man for Texas Gulf Coast area to handle tube fittings. Box 564.

SALESMAN. Experienced in the sale of control equipment for the boiler plant and process industries as particularly related to the petroleum and chemical fields in the N. Y. area. Large established manufacturer of complete line of power plant and industrial instruments for the measurement and automatic control of flow, level, pressure, draft, temperature. Salary will depend on qualifications. Give complete resume of education, training and job experience in first letter. Box 565.

SALES ENGINEER. Leading manufacturer pressure and temperature gauges and industrial instruments wants man 25 to 35 to cover Northern Ohio with Cleveland as base. Car and some sales experience preferable along instrument lines absolutely necessary. Salary and expenses, excellent opportunity. Give resume of record in first letter. Box 566.

SALES ENGINEER. Wanted by well established manufacturer of industrial thermometers, dials, recorders and controllers, to work out of its Detroit office. This is a genuine opportunity for an aggressive man experienced in instrumentation. State fully background, education and experience in first letter. Box 567.

SALES ENGINEER. For Southeastern territory to handle complete line of indicating, recording and controlling instruments for temperature, pressure, flow etc. on salary and expense basis. Prefer man over 32 years of age with sales and instrument experience. Must be engineering graduate and willing to locate in the Southwest. Salary dependent on experience. Box 568.

SALES ENGINEERS. For large instrument manufacturer. Definite opportunity for wide selection of field jobs after training at Headquarters in Pittsburgh, Pa. Box 569.

INSTRUMENT SALESMAN. By Philadelphia organization, to cover local territory. We have a complete line of industrial control equipment needed by an ever increasing industrial market. Base salary, commission, and expenses. Give full information in your letter concerning education, experience, etc. All replies are confidential. Our employees know of this ad. Box 570.

MANUFACTURER'S REPRESENTATIVE. For Electrical Instruments and Precision Resistor Line Prefer contact with established manufacturers handling associated lines. Box 571.

INSTRUMENT FOREMAN. Experimental installing, repairing, testing, and calibrating major makes of instruments and controls such as Brown, Foxboro, L & N, Taylor, etc. Proper person will be responsible for installation and maintenance of all instruments and controls in a small chemical plant located at Lake Charles, La. This is a permanent position with a growing company. Submit experience, education, age and salary expected. Box 572.

INSTRUMENT MECHANIC. For Installation and Repair of Instruments common to Chemical Process Industries. Starting rate $2.04½ per hour. Location New Jersey. Box 573.

INSTRUMENT MECHANICS. With 2 or more years experience in the installation, maintenance and repair of all types of industrial and electronic instruments. Location General Electric, Richland, Washington. Box 574.

INSTRUMENT MECHANIC. Experienced in the installation and adjustment of steam plant instruments and automatic combustion controls preferred. Knowledge of electricity essential. Permanent position in Service Dept. of manufacturer with considerable traveling in the U. S. Write giving details of background, education and experience. Location near Chicago. Box 575.

INSTRUMENT MECHANIC. The City of Port Arthur, Texas needs an electrical instrument mechanic in the Water Dept. Must be familiar with the usage and repair of instruments used in water work and should have training in Cathodic protection work. Man would be on his own and would be required to exercise his own judgement under all conditions. Monthly salary according to ability. Box 576.

INSTRUMENT MECHANIC. Experienced in pneumatic and electrical controls as used in oil refinery or chemical plant. $2.22 per hr., forty hr. week, liberal benefit plan and good working conditions. Location St. Louis area. Box 577.

INSTRUMENT MECHANIC. Experienced instrument maintenance, familiar with control as used in Petroleum Refinery. Permanent po-

sition with usual benefits including Pension Plan. Located in Lower Rio Grande Valley. Box 578.

MECHANICS—TECHNICIANS. Manufacturer of indicating type instruments requires: Experienced instrument assemblers of various makes. Also experienced foreman. Location Los Angeles, Calif. Box 579.

INSTRUMENT TECHNICIAN. For servicing present extensive equipment; supervising installation of new instruments; assisting in specifications, designs and applications for new equipment. Should have two to five years industrial experience in instrumentation. Will be in charge of dept. Salary commensurate with experience. Give complete details in first letter. Location Illinois. Box 580.

INSTRUMENT TECHNICIANS. For aircraft instrumentation. Starting rate and future advancement commensurate with ability, experience and background. Excellent working conditions and liberal employee benefits, a future with a progressive company. Location St. Louis 3, Mo. Box 581.

INSTRUMENT TECHNICIANS. Several years experience repairing, testing and calibration on major makes of instruments and controls such as Brown, L & N, Bailey, Taylor and Foxboro. Education 2 years of college or the equivalent. Age 25-50. Permanent position in Detroit area. Furnish full details including salary expected. Box 582.

INSTRUMENTATION TECHNICIANS. For Aircraft and Guided Missile flight test and performance program. Excellent opportunity for experienced people. Long term contract. Finest working conditions. Attractive compensation commensurate with experience. Location San Diego, Calif. Box 583.

INSTRUMENT TECHNICIAN. Experienced installing, repairing, testing, and calibrating major makes of instruments and controls such as Brown, Foxboro, L & N, Taylor, etc. Proper person will be responsible for installation and maintenance of all instruments and controls in a small chemical plant located at Neville Island, Pittsburgh, Pa. This is a permanent position with a growing company. Submit experience, education, age and salary expected. Box 584.

INSTRUMENT TECHNICIANS. With five years experience on pneumatic receivers and transmitters. Ability to calibrate all types industrial flow meters. Maintain most types of automatic controllers and put into operation temperature, pressure and level type instruments. Columbia Cellulose Co., Prince Rupert, B. C. Box 585.

INSTRUMENT TECHNICIANS. Instrument Department now being formed for Atomic Energy Commission plant at Aiken, S. C. Requirement cover fields of industrial process instrumentation, radiation instruments, electronics and servomechanisms. Plant to be operated by E. I. duPont de Nemours & Co. Box 586.

INSTRUMENT TECHNICIAN. Experienced-Instrument Maintenance. Familiar with process control as used in Refining or Chemical Industry. Modern shop equipment. Permanent with established company. Location Corpus Christi, Texas. Box 587.

INSTRUMENT TECHNICIANS. Instrument technicians, electro-mechanical with 5 years minimum experience in calibration, repair and modification of aircraft or industrial instruments. Instrument making experience highly desirable. Location New Mexico. Box 588.

ELECTRONIC MECHANICS. For paper manufacturing company located in eastern part of North Carolina, 110 miles south of Norfolk, Va. Box 589.

INSTRUMENT MAKERS AND TESTERS. Wanted for work on analytical electronic instruments. Ideal working conditions in large new plant in Southern California. Box 590.

TOOL MAKERS, SET UP MEN, and OPERATORS are needed for Swiss Automatic Screw Machine in the manufacture of Instrument Parts. Location Santa Monica, California. Box 591.

GOVERNMENT SERVICES

To apply for any of the following Federal Agency positions, write direct to the Agency holding the position, for official application form.

INSTRUMENT ENGINEERS. Graduate Engineers. The applications section of the instrument dept. at Oak Ridge National Laboratory operated by Carbide & Carbon Chemicals Co. is being enlarged to provide instrument engineering for expanding programs. Work entails selection of proper instrumentation, design of components, design of panels, installation follow-up, writing of service specifications and service instructions. Give background data in first letter. Location Oak Ridge, Tenn. W. H. Brand, Supervising Engineer, Instrument Dept., Oak Ridge National Laboratory, P. O. Box P, Oak Ridge, Tenn.

ELECTRICAL ENGINEER GS-9, Starting salary $4600. BS with two years experience required. Position concerns development, design, supervision of construction, test and operation of ground stations for testing telemetering instrumentation in Guided Missiles. Chief Civilian Personnel Section, Redstone Arsenal, Huntsville, Ala.

ELECTRICAL ENGINEER GS-11. The functions and responsibilities are development of magnetic and electrical influence firing mechanisms and associated components for use in mines and anti-submarine weapon systems; development of basic influence detectors, associated amplifier and discriminator systems, and the necessary electromagnetic instrumentation to complete these developments. Naval Ordnance Laboratory, White Oak, Maryland.

ELECTRICAL ENGINEER GS-11. Design, development, modification, and research on pulse-type high power transmitters, electrical and electronic controls and instrumentation; very high frequency receivers, and similar apparatus. Naval Ordnance Laboratory, White Oak, Maryland.

ELECTRICAL AND ELECTRONIC ENGINEERS. $3825 to $5400. Design, Development, Operation. Electronic Flight Test Instrumentation. Work in well equipped laboratory and in the field. Several trips aboard aircraft carriers a year. (not mandatory). Instrumentation Branch. Flight Test Division. Naval Air Test Center. Patux ent River, Maryland.

ELECTRICAL, ELECTRONIC ENGINEERS and PHYSICISTS. Location—Johnsville, Pa. (10 miles north of Philadelphia, Pa.). Employment opportunities in the field of Armament development and test. Salary range $3825 to $6400 (per annum) Industrial Relations Dep't., Aviation Armament Lab., Naval Air Development Center, Johnsville, Pa.

ELECTRONICS ENGINEER GS-11. Research development and final design of firing systems. Should have experience in microwave radio, miniature tubes and circuits, and design research. Naval Ordnance Laboratory, White Oak, Maryland.

ELECTRONICS ENGINEER GS-11. Will include work with many types of electronic gear and related equipment, servo systems, and fire control apparatus. Naval Ordnance Laboratory, White Oak, Maryland.

ELECTRONICS ENGINEER. GS-11. Original research and development on electronic and radio equipment. Designs instrumentation for guided missile program. Naval Ordnance Laboratory, White Oak, Maryland.

MECHANICAL ENGINEER GS-11. Eligibles will be project engineers responsible for the design of warheads for guided missiles. Naval Ordnance Laboratory, White Oak, Maryland.

MECHANICAL ENGINEER GS-9. Starting salary $4600. BS with two years experience required. Position concerns development, design, supervision of construction, test and operation of ground stations for testing telemetering instrumentation in Guided Missiles. Chief Civilian Personnel Section, Redstone Arsenal, Huntsville, Ala.

ENGINEERS. Research, development and testing activities with the U. S. Navy at the David W. Taylor Model Basin Washington, D.C. Electronic, Electrical, Mechanical, and Structual Engineers in base salary range from $3100 to $5400. With current overtime rates, from $3654 to $5842. (salaries range).

GENERAL ENGINEER GS-9. Design and Drafting Division. This position involves analysis of drawings of mechanical devices to determine their completeness and correctness. A knowledge of shop techniques and mechanical drawings required in addition to professional engineering experience or education. Naval Ordnance Laboratory, White Oak, Maryland.

PHYSICIST GS-13. Scientific Research Administrator for Missiles Program. Naval Ordnance Laboratory, White Oak, Maryland.

PHYSICIST GS-11. Will perform evaluation studies or electronic systems. Naval Ordnance Laboratory, White Oak, Maryland.

PHYSICIST or ELECTRONIC SCIENTIST GS-11 or 12. Evaluation of electronic systems. Should have microwave experience. Naval Ordnance Laboratory, White Oak, Maryland.

PHYSICIST GS-11. General. Naval Ordnance Laboratory, White Oak, Maryland.

PHYSICIST GS-9. Starting salary $4600. BS with two years experience required. Position concerns development equipment and test of temperature measuring in Guided Missiles. Chief Civilian Personnel Section. Redstone Arsenal. Huntsville, Ala.

PHYSICISTS. Research, development, and testing activities with the U. S. Navy at the David W. Taylor Model Basin Washington, D. C. Positions in salary range from $3654 to $6795 are open. (Base pay plus overtime).

INSTRUMENTATION SCIENTISTS. A program in basic instrumentation research is underway at the National Bureau of Standards cooperatively sponsored by ONR, Air Force, and AEC, involving theoretical and experimental research development, design, evaluation, and technical reference work in the broad field of measurement and control instrumentation. Excellent opportunities are open for qualified scientists and engineers in a broad variety of basic instrumentation problems. Salaries range from $3825 to $7600 per year. Further information concerning these positions can be obtained from W. A. Wildhack, Chief, Office of Basic Instrumentation, National Bureau of Standards, Washington 25, D. C.

MATHEMATICIANS. Research, development and testing activities with the U. S. Navy at David W. Taylor Model Basin Washington, D. C. Positions in salary ranges from $3654 to $6795 are open. (Base pay plus overtime).

INSTRUMENT MECHANICS. Are needed in the Instrument Department of the Oak Ridge National Laboratory. Work involves maintenance of numerous types of pneumatic and electronic process instruments—also radiation instrumentation. Area—Housing available. Employment Supervisor, Oak Ridge National Laboratory, Oak Ridge, Tenn.

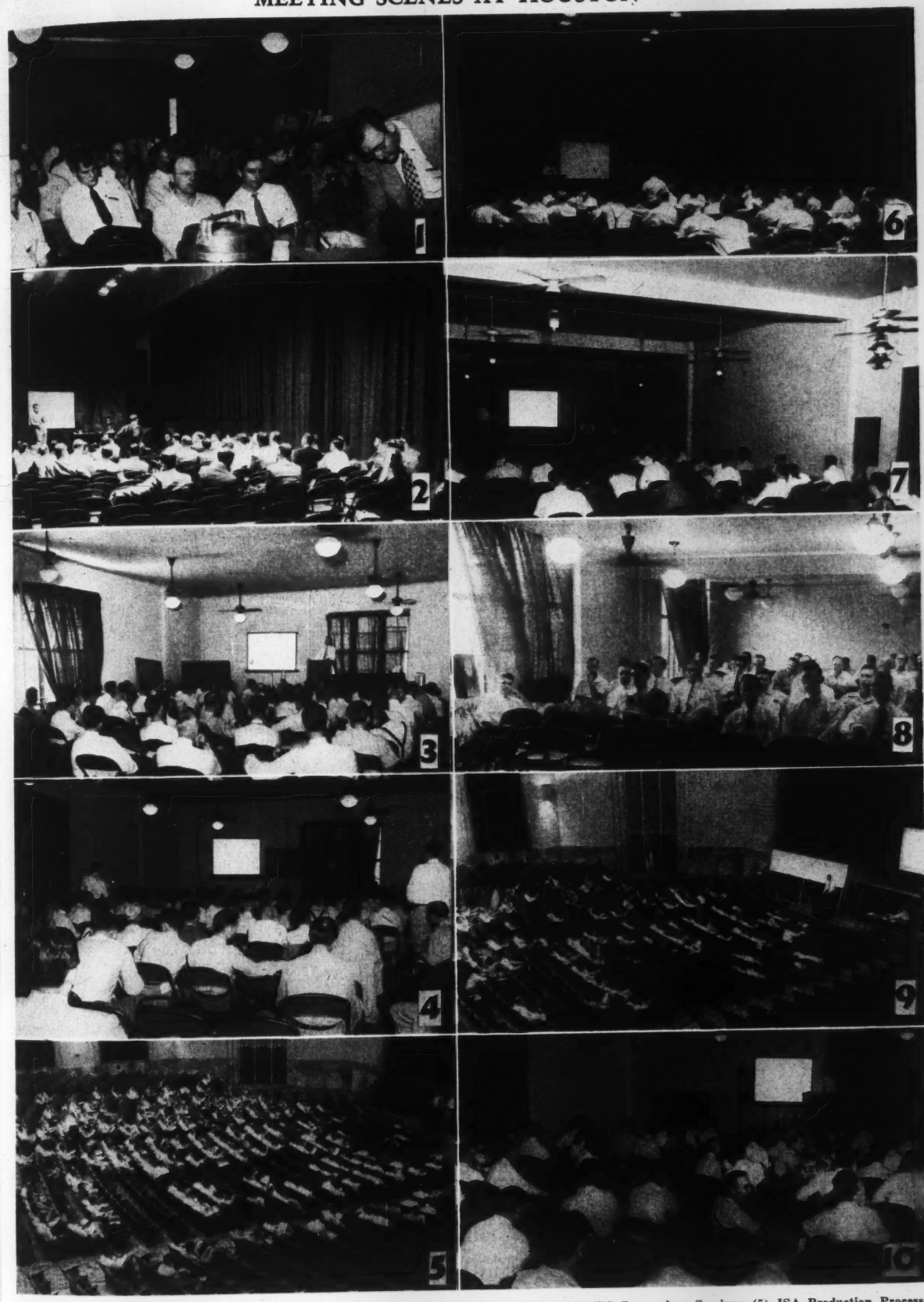
MECHANIC, FIRE CONTROL INSTRUMENT. The U. S. Naval Ammunition Depot, Crane, Indiana, is accepting applications for the position, Mechanic-Fire Control, $1.72 per hr. The work is in the field of Ordnance Fire Control Equipment. Navy experience and (or) instrument repair work for a total of 4 years is required. Wm. M. Kolb, Ordnance Engineer, USNAD, Crane, Ind.

INSTRUMENT REPAIRMAN WB-20. Position concerns modification, test and repair of mechanical instruments in Guided Missiles for telemetering. Chief Civilian Personnel Section, Redstone Arsenal, Huntsville, Alabama.

ISA CONFERENCE AND EXHIBIT PICTORIALS

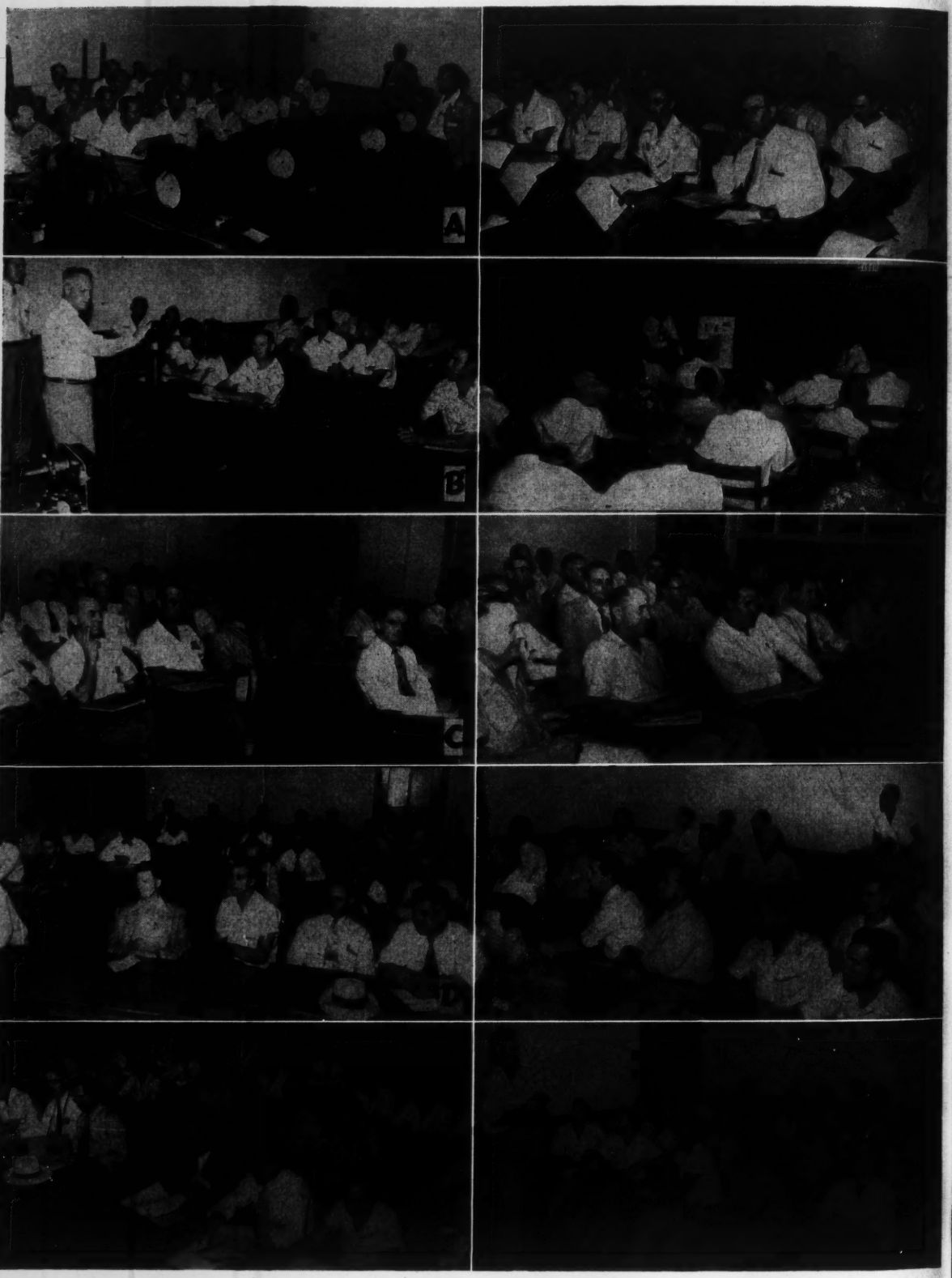
Pages 1227-1232 of the *Journal*.
Pages 1160-1167 of *Instruments*.

MEETING SCENES AT HOUSTON

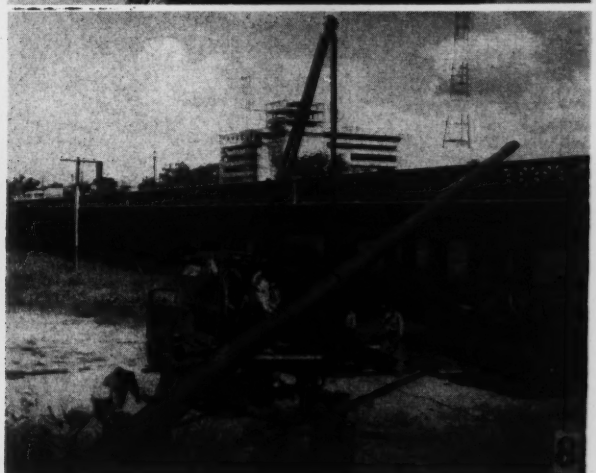


(1) IRE Session; (2) Gulf Coast Spectroscopic Group Session; (3) AIP Session; (4) RDB-NBS Symposium Session; (5) ISA Production Processes Session; (6) AIEE Session; (7) ISA Testing; (8) NACE Session; (9) Pipe Liners Club Session; (10) ISA Maintenance & Operation Session.

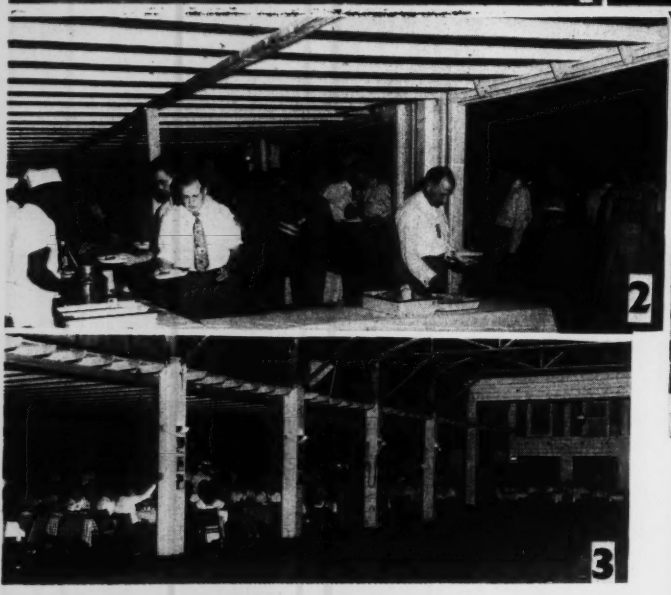
ISA INSTRUMENT MECHANICS' MAINTENANCE CLINIC DRAWS 372



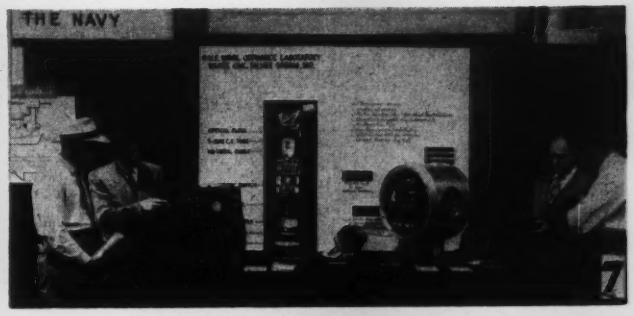
Photos were taken between 2 and 2:30 p.m. on Friday, September 7. (A) Foxboro Session; (B) Fisher Governor Session; (C) Republic Flow Session; (D) Mason-Neilan Session; (E) Brown Instrument Session; (F) Manning, Maxwell & Moore Session; (G) Moore Products Session; (H) Leeds & Northrup Session; (I) Hagan Session; (J) Taylor Instrument Session.

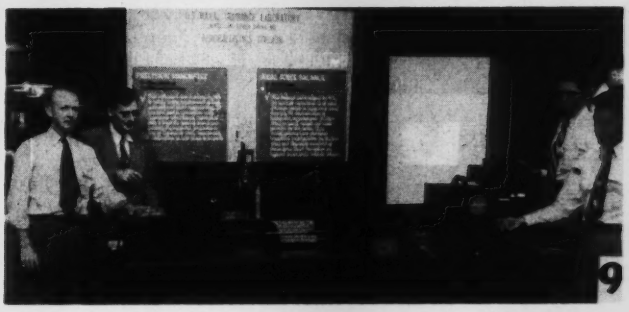


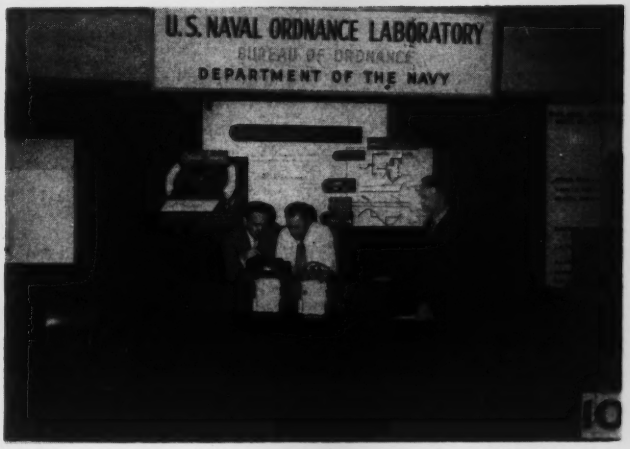
GENERAL SHOW VIEWS: (1) Registration at the Clinic; (2) ISA Board of Directors Meeting; (3) ASME Luncheon; (4) Opening Day Registration; (5) Clinic Students at lunch in University of Houston cafeteria; (6) SAMA Luncheon; (7) First of five daily Press Breakfasts; (8) Erecting power line to supply air compressor for exhibit.

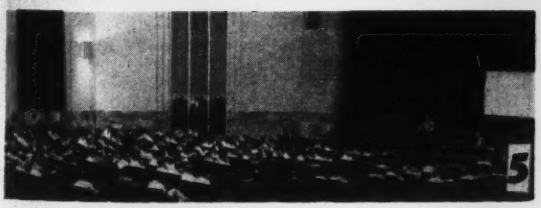


RECREATION & RELAXATION TOO: (1) Dancing at Plantation Barbecue Party; (2) Seconds; (3) Over-all; (4) Turtle race; (5) Clinic Students relax; (6) Song at the Barbecue Party; (7) Sit and Talk; (8) Another view of Clinic registration.







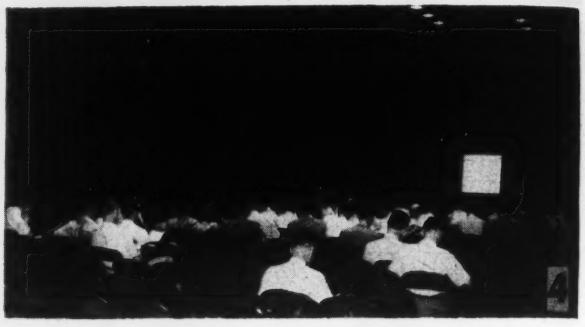


U. S. NAVY EXHIBITS

Shots 1 to 4 and 7 to 10 show views of U. S. Navy Exhibits.

Texas A & M Symposium Session is shown in Shot 5.

Shot 6: ISA Film Showing, "Principles of Automatic Control."



MISCELLANEOUS VIEWS

Fig. 1. Dow Chemical Engineers and Researchers arriving in Houston by Company plane.

Fig. 2. Rimbach meets executives of four German instrument manufacturers at Houston Airport after they had flown 5000 miles from Frankfort, Germany.

Fig. 3. Air Compressor Installation which supplied air to Exhibitors. Air compressor was loaned to the Society by Nash Engineering through the courtesy of George Wright.

Fig. 4. ASME Technical Session.

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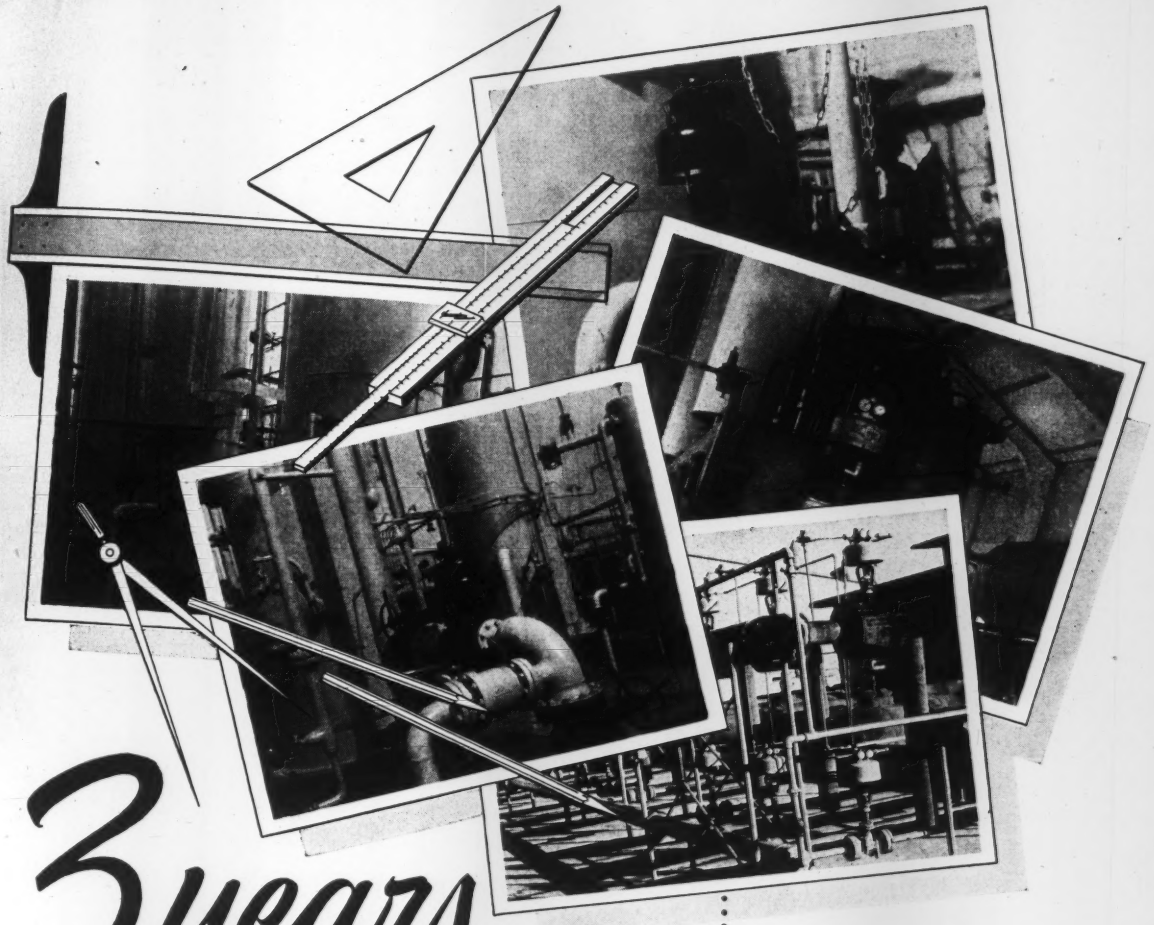

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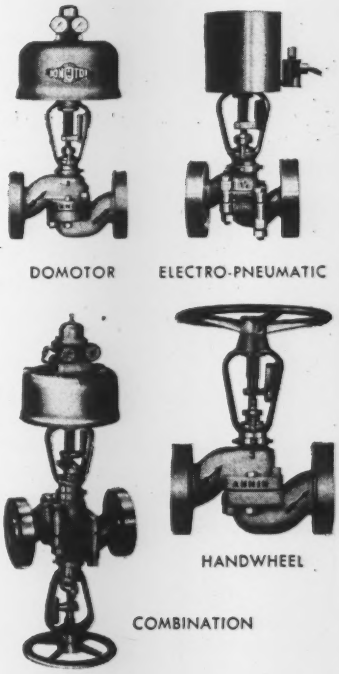

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TELEMETERING DEVELOPMENTS

By J. W. PECKHAM, The Bristol Company, Los Angeles, Calif.

Recent telemetering developments in the California utilities system include recording and controlling by use of only one leased wire, automatic scanning of several transmitters, and individual point check.

THERE have been a number of interesting telemetering installations recently. Most of these have been developed in collaboration with the engineering personnel of local utilities. However, the basic principles involved

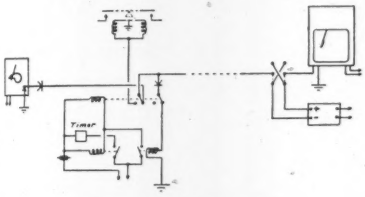


Fig. 1. Remote switching device.

are of general interest. It is assumed that the reader is familiar with telemetering equipment which uses impulses of variable time duration. The reader is referred to W. A. LaViolette's article in Proceedings P.C.G.A., 1949, Page 173, for a comprehensive description of basic Metameter units.

One important characteristic of the variable time impulse system is the ability of the system to return to normal operation following power failure at the transmitter or at the receiver, or interruption of the signal circuit either by short circuit or grounding. As soon as normal facilities are restored, the system goes back to work on the first complete impulse without need for synchronization or checking of any kind. This enables you to tear the circuit apart for a few minutes, use it for a different function, then put it together again and get an immediate record of an action at a remote point.

Recording and Controlling

Sometimes it is desirable that a local operator adjust valves or controllers at a remote location and also receive records of pressure, flow, etc., from the remote point. Many telemetering installations use leased-wire facilities. As some public utilities have strict limitations on the use of circuit facilities, it has been necessary to lease two separate communication channels in order to get both recording and control functions. To cut down on leased-wire charges, a remote transfer device has been developed which provides either recording or controlling over the same circuit, alternately, without violating the operating restrictions imposed by the utility. Fig. 1 shows how this is accomplished. A combination of polarity-sensitive relays and half-wave rectifiers at the remote point temporarily disconnect the telemetering equipment, reconnect the line so that it can be used for adjusting control functions and, after a preset time interval, the line automatically is restored to its telemetering function. The first installation has been operating from Spence Street to Alhambra Station for about a year with satisfactory reliability. Other installations are now under construction.

An interesting combination of a Metameter controller with fail-safe feature at the unattended station is shown in Fig. 2. This illustrates the use of an inherent characteristic of the Metameter to obtain fail-safe action. Whenever the signal circuit of a Metameter system is interrupted by an open or ground, the recording pen travels to an extreme position, outside the calibrated limits of the chart. The normally-closed limit switches, X and Y, are connected so that the power supply to the motor which operates the valve is cut off, thereby maintaining control at the last position of the valve and simultaneously operating an alarm circuit to warn operators. This particular application is on electrically-operated equipment, but the same interlocking principle might be used with solenoid valves. Note that the remote station returns to normal operation, without supervision, as soon as circuit faults are cleared.

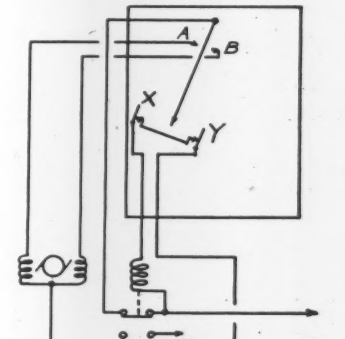


Fig. 2. Metameter controller with fail-safe feature.

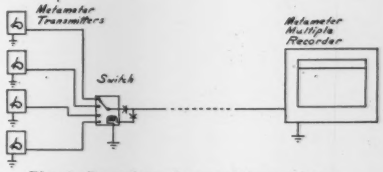


Fig. 3. Scanning of several transmitters.

Automatic Scanning

More information can be transmitted over leased-wire facilities without increasing costs by automatic scanning of several transmitters, as shown in Fig. 3. This is only one of several combinations that can be used. Where conditions are such that continuous readings of the several variables are not required, a multiple-point strip-chart recorder provides an economical solution. As many as 16 values can be recorded on a single strip chart. Assuming a 5-second impulse time, and 3 impulses on 15-second print time, a 16-point multiple would scan the entire group once every 4 minutes.

If some values require more frequent reading, they could be wired in so that they would repeat every 4th

November Meeting: In place of the regular monthly meeting, an "Instrument Maintenance Short Course," sponsored by SCMA, will be presented by the Los Angeles Harbor Junior College on their campus. The three-day session will start Thursday, November 15th, at 1:00 P.M.

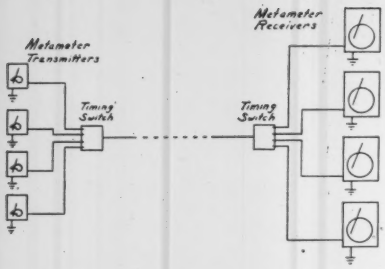


Fig. 4. Scanning of several transmitters with individual receivers.

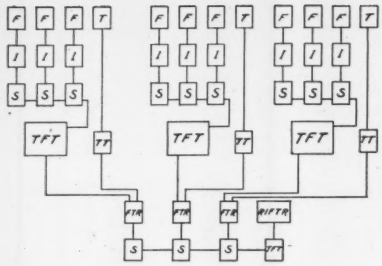


Fig. 5. Block diagram of gas system with totalization.

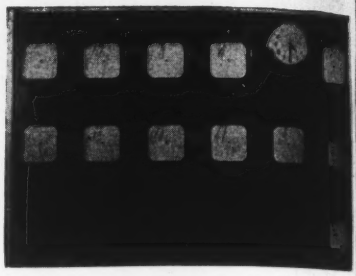


Fig. 6. Point Richmond Control Station of P. G. & E. Co.

point, instead of every 16. Scanning systems of this type have one disadvantage—in the event of line failure, the recorder is not able to tell which point was being transmitted after circuit facilities are restored. To overcome this, a homing-type stepping switch is provided at S, which is actuated by a reverse-polarity pulse from the recorder at the beginning of each group of 16 points. In this way, the recorder automatically synchronizes the complete system as soon as it reaches No. 1 point in the printing cycle.

There are many applications where the round chart record is more desirable than the strip chart. In such applications, the scanning system shown in Fig. 4 has been operated experimentally with satisfactory results. This combination requires careful synchronism of the timing switches at transmitter and receiver locations, with added provision for holding the pen-actuating mechanism in the last recorded position until the next reading impulse is received.

Point Check

There are some applications where it is not necessary to have continuous records of all transmitting points, but it is desirable to check any one point at will. A pipe-line installation is a typical illustration. To provide service with minimum cost, existing selective or coding relays should be used. These relays operate over a single line to select any one of several points. Thus pressure, temperature, flow, or any other variable, can be picked up and held as long as required from any point on the long line. This selector system offers an economical method for checking desert locations on a pipe line when used in connection with a d-c. timing-motor drive in transmitters, as described in a recent paper by W. L. Masheter, of Southern Counties Gas Company — "A Telemetering System which does not use Commercial Power at Transmitter," presented at P.C.G.A. Technical Services Conference, March 7, 1951 and published in *Instruments* (SCMA Journal), May, 1951.

Totalizing

The totalizing of system flow has been common in electrical transmission systems for several years. The use of telemetering is an integral part of such systems. The application of the same basic system to gas transmission systems is simply a matter of changing the primary instrument from a wattmeter to a flowmeter. A recent installation of gas-system totalizing in an eastern location shows some interesting features. Fig. 5 is a block diagram of a system in which the primary measurement is by means of pressure-compensated flowmeters, which transmit to indicating receivers with integrators on each sub-station flow. The signal also actuates slide-wire receivers which are interconnected to give a total flow.

An addition to this system is an auxiliary recording and integrating total-flow recorder, which is equipped with contacts on the integrator to automatically inject odorant into the incoming line. Although this system is arranged to add all flows for a grand total, it might be set up to give an algebraic summation of flows both into and out of the system. This might be of special interest where part of the flow goes into the distribution system, and the balance goes to storage or interchanges with adjacent systems.

Remote Operation

Remote operation of a compressor station is planned for a new installation now under construction in the Bay Area. This installation includes a considerable amount of telemetering, most of it standard equipment. The main points of novelty are in supervisory control, interlocks, and fail-safe provisions. Automatic start-up sequence control is included, with indicators at the operator's station showing completion of each vital operation in the sequence. The self-restoring feature of the Metameter system is a necessary part of the over-all design of a comprehensive remote-controlled station.

Some local installations of telemetering on compressor stations are partially automatic, with all functions except start-up and shut-down of the compressor remotely supervised, recorded, and controlled. A recent installation of Metameters on crude-oil pipe line between Sunset and McKittrick has made it possible for an operator at McKittrick to check temperature, pressure, and flow rate of the output of Sunset Pumping Station, 30 miles away. Ex-

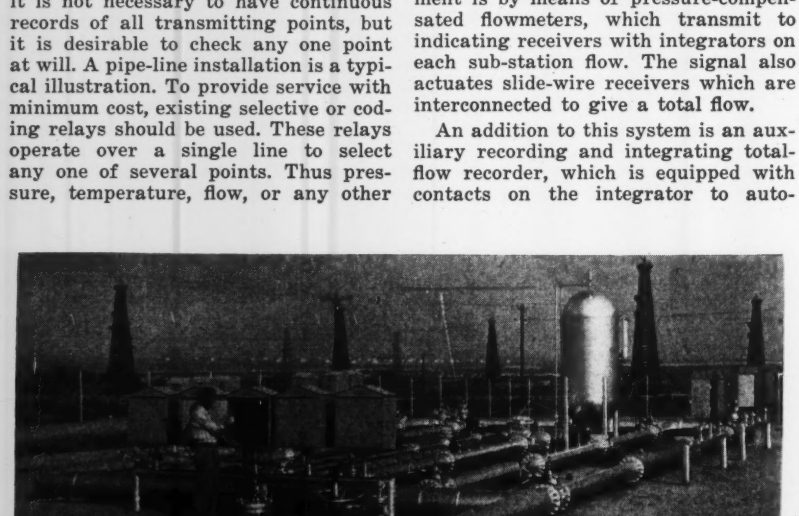


Fig. 7. Buena Vista Measuring Station of Southern California Gas Co.

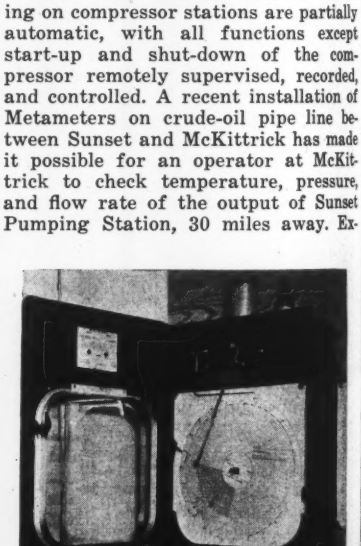


Fig. 8. Telemetric receiver and control switch in the Taft Office.

cept for start-up of the engines at Sunset, the station operates unattended. (See Union Oil Co. *On Tour*, January 1951 issue, pages 16-17.)

In the Bay Area, the new Point Richmond Control Station of the P. G. & E. Co. (Fig. 6) has several features of interest. This panel is located at the new 17,000,000 cu. ft. holder and controls transmission and distribution substations for Richmond, Albany, and nearby areas. An unusual feature of this installation is the fact that the 24-pair communication cable is run inside the pipe line for about seven miles. A complete description of this installation is given in an article by W. A. LaViolette —"Remote Control & Telemetering Cable Goes Inside the Gas Pipe Line," which appeared in April 27th and May 11, 1950, issues of *Gas Age*.

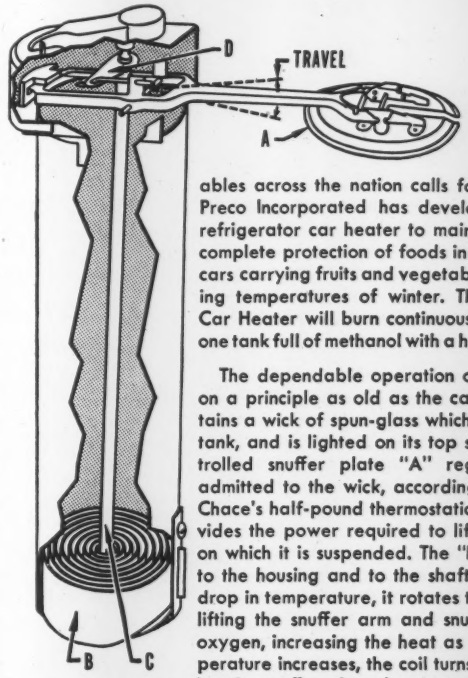
The extent to which Metameter equipment is being used in a modern transmission and distribution system is indicated by the fact that in the Southern California Gas system are 600 miles of telemetering circuits and over 140 Metameter installations.

Out in the sage brush, it often occurs that there is a regulating station where telemetering and remote control is desirable, but where there is no local source of a-c. power available. One such station is the Buena Vista Measuring Station of the Southern California Gas Company in the San Joaquin Valley, shown in Fig. 7. It is possible to send enough a-c. power from the receiver location to the sending station; then, by use of suitable filters, the measured valve telemeter signal is sent back over the same pair of wires. In the Buena Vista Station, a-c. power was picked up at an intermediate point, but the basic principle is the same.

The control station at Taft (Fig. 8), from which Buena Vista is operated and controlled, recently installed a panel at their Venice Station, which supervises and remotely controls the distribution for the area from Culver City to Malibu—west of Sepulveda Boulevard. This central control receives Metameter readings of pressure at strategic points in the distribution system and also provides remote operation of sub-stations at Stanford Ave., Arvee St. One instrument controls differential, transmits Metameter signals to Venice Station, and also is equipped with electrically-operated set-point adjustment so that the operator at Venice can raise or lower the control point.

The economics of telemetering equipment naturally are of interest. Recent studies on a strict accounting basis have indicated that remotely-operated control stations pay for themselves out of savings in about two years. Another study of cost was made by a group of graduate students in instrumentation at University of California, Berkeley, about three years ago. They found that $20,000 of instrument installation could be justified if one man, on 3-shift basis, could be relieved. That figure, of course, is subject to considerable variation with different accounting practices.

Preserves Precious Provisions



The transportation of perishables across the nation calls for ingenuity to prevent spoilage. Preco Incorporated has developed this safe methanol-burning refrigerator car heater to maintain the proper temperature for complete protection of foods in the endless trains of refrigerator cars carrying fruits and vegetables across the country in the freezing temperatures of winter. The Preco Automatic Refrigerator Car Heater will burn continuously at full flame for fifty hours on one tank full of methanol with a heat output of 6000 BTU's per hour.

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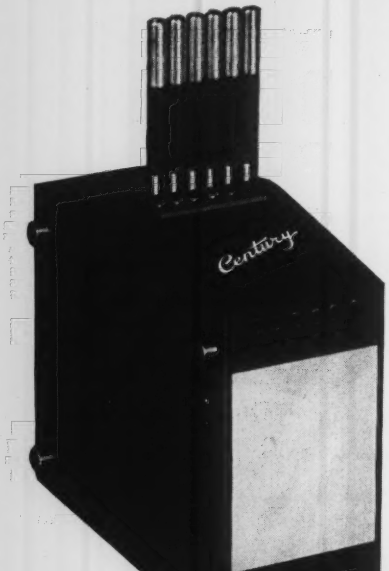

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Requests for literature FROM ABROAD should be made on company letterhead and mailed DIRECTLY to the manufacturers.

Temperature

T-769 **Miniature Thermometer.** 1-page bulletin illustrates and describes miniature fast-action thermometer.—Velan Engineering Co., 1 Exchange Pl., Jersey City, N. J.

T-770—**Temperature and Pressure Regulators.** 4-page Bulletin 751 illustrates and describes maker's precision pressure regulators, temperature regulators, and combination pressure-temperature regulators.—O. C. Keckley Co., 400 W. Madison St., Chicago 6, Ill.

T-771 **Temperature and Pressure Instruments.** 4-page brochure illustrates maker's line of indicating and recording thermometers, pressure gages, air-operated controllers, "Ford" viscosimeter, and diaphragm-motor valves.—Scientific Instrument Co., Detroit, Mich.

T-772 **Fire Detection.** 16-page booklet discusses "rate-compensation" principle of fire detection in comparison with other techniques.—Fenwal, Inc., Ashland, Mass.

Pressure

T-773 **Absolute-pressure Controller.** 4-page Publication TP-37-A illustrates and describes maker's aneroid-type instrument for measuring and controlling absolute pressure.—Wallace & Tiernan Products, Inc., Belleville 9, N. J.

T-774 **Pressure Transmitters.** Data folders illustrate and describe line of pressure transmitters which use maker's differential-transformer transducers. Primary elements are Bourdon tube, gage-pressure bellows, absolute-pressure bellows, or differential-pressure cell.—Automatic Temperature Control Co., Inc., 5200 Pulaski Ave., Philadelphia 44, Penna.

T-775 **Pressure Snubbers.** 2-page bulletin illustrates and describes maker's new "Micro Metallic" pressure snubber for dampening pulsations. Includes features and applications.—Chemiquip Co., 6 E. 97th St., New York 29, N. Y.

T-776 **Tensiometer.** 8-page Bulletin GEA-5512 illustrates and describes maker's tension indicator for cold-rolled strip in steel, brass, and aluminum mills. Includes principles and operation.—General Electric Co., Schenectady 5, N. Y.

T-777 **Safety Heads.** 8-page brochure discusses use of maker's safety heads in compressed-air systems.—Black, Sivalls & Bryson, Inc., Kansas City, Mo.

Flow

T-778 **Induction Flowmeter.** 12-page brochure illustrates and describes new "Magnaflow" induction-type flowmeter which measures voltage induced in medium flowing through a magnetic field.—Mittelmann Electronics Div., Century American Corp., 549 W. Washington Blvd., Chicago 6, Ill.

T-779 **Flowmeter and Tachometer.** 4-page Bulletin 1050 illustrates and describes new electronic flowmeter which uses rotor in flow channel and electronic tachometer.—Potter Aeronautical Co., 87 Academy St., Newark 2, N. J.

T-780 **Flow Transmitter.** 12-page Catalog 2281 illustrates and describes maker's "Differential Converter" which converts small differential pressures into proportional air-pressure signals.—Industrial Div., Station 40, Minneapolis-Honeywell Regulator Co., Philadelphia 44, Penna.

T-781 **Flow Transmitter.** 8-page Bulletin 2551 illustrates and describes new pneumatic pressure-differential signal transmitter. Includes principles, construction, and applications.—Hagan Corp., Hagan Bldg., Pittsburgh 30, Penna.

T-782 **Controlled-volume Pumps.** 8-page Bulletin 262 illustrates and describes maker's line of "Pulsafeeder" piston-diaphragm pumps for controlled-volume pumping of fluids.—Lapp Insulator Co., Inc., Leroy, N. Y.

T-783 **Controlled-volume Pumps.** 24-page Bulletin 151 illustrates and describes maker's line of controlled-volume pumps. Includes principles, materials usable in various applications (corrosion resistance), and "packaged" systems.—Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Penna.

T-784 **Controlled-volume Pump.** 2-page data sheet describes new micrometer stroke adjustment for "U"-type pump.—Hills-McCanna Co., 3025 N. Western Ave., Chicago 18, Ill.

T-785 **Oil Meter.** 2-page Bulletin 31 illustrates and describes maker's high-pressure oil meter and "Wellflooder" water meter.—Buffalo Meter Co., 2917 Main St., Buffalo 14, N. Y.

T-786 **Chemical Injectors.** 4-page brochure illustrates and describes maker's line of controlled-volume pumps for injecting chemicals, rust inhibitors, etc.—Bettis Corp., P. O. Box 9091, Houston 11, Texas.

Process Controllers

T-787 **Electronic Control System.** 4-page Bulletin A-701 illustrates and describes new "Autronic" miniature all-electronic system for process control. Includes features and applications.—The Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.

T-788 **Recorder-controllers.** 24-page Catalog 500 illustrates and describes maker's line of recorders, air-operated controllers, and camless program recorder-controllers.—Gotham Instruments, Div. of American Machine and Metals, Inc., Sellersville, Penna.

T-789 **Controller.** 2-page Bulletin CL-1 illustrates and describes maker's "Capaciline" unit which adds anticipatory (derivative) control to existing on-off control systems.—Wheelco Instruments Co., Chicago 7, Ill.

T-790 **Pneumatic Timers.** 2-page Bulletin N-100 illustrates and describes maker's timers with new cam-operated pilot valves for process programming.—Automatic Temperature Control Co., Inc., 5212 Pulaski Ave., Philadelphia 44, Penna.

Steam, Water Level, etc.

T-791 **Power-plant Equipment.** 12-page Bulletin S-196-C illustrates and describes maker's line of control valves, pressure master controls, desuperheaters, temperature master controls, water regulating valves, liquid level and drainage controls, differential pressure controls, feed-water heaters, feed-water regulators, separators, exhaust heads, air separators, and accessories.—The Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.

T-792 **Boiler-room Instrumentation.** 8-page Bulletin R-6 illustrates and describes modernization and expansion of boiler room in brewing company, including equipment and building changes.—The Hays Corp., Michigan City, Ind.

T-793 **Tank-Venting Equipment.** 32-page Bulletin No. CP-2001 describes maker's "Varec" tank-venting equipment, flame arresters, relief valves, and vent valves.—Vapor Recovery Systems Co., 2820 No. Alameda St., Compton, Calif.

T-794 **Steam Trap.** 14-page brochure illustrates and describes maker's steam trap with check valve, strainer, sight glass, and temperature indicator and control.—Velan Engineering Co., 1 Exchange Pl., Jersey City, N. J.

Optical

T-795 **Microscope.** 24-page issue No. 101 of house organ "Balco News" features article on ball-bearing type microscopes.—Bausch & Lomb Optical Co., Rochester, N. Y.

Chemical Analysis

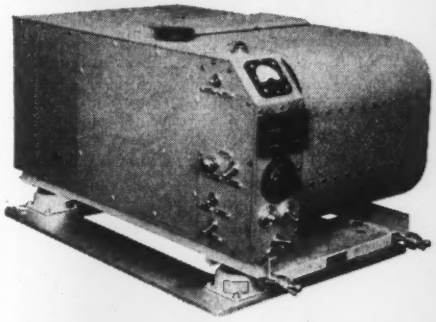
T-796 **Infrared Analysis.** 8-page booklet "Product Control By Infrared Analysis" illustrates and describes principles of infrared analysis.—The Perkin-Elmer Corp., Norwalk. Conn.

T-797 **Gas Analysis.** 4-page Brochure BRF-951 illustrates and describes maker's "Ever-tite" thermal conductivity units for gas analysis. Includes

Century INDUSTRIAL

RECORDING OSCILLOGRAPH

FOR VIBRATION, TEMPERATURE, STRESS, STRAIN ANALYSIS



MODEL 408 OSCILLOGRAPH

The Century Model 408 recording oscillograph was designed expressly for airborne and mobile operation. As with all Century products, this oscillograph incorporates the utmost in design and workmanship, along with improved features, yet it remains simple in its operation and maintenance.

FEATURES:

Size: 10" long, 12½" wide, 8⅞" high.

Weight: 60 pounds.

Number of Recording Channels: 6 to 50.

Detachable daylight loading magazine accommodating a roll of paper or film 8" x 200'.

Friction roller type paper drive by governor controlled electric motor with separate motor for takeup drive.

Paper speeds continuously and instantly variable without changing gears or sprockets.

Separate optical system for viewing before or during recording.

Glow tube timing system photographing .01 second and .1 second lines. .01 second lines instantly removable by toggle switch for slower speeds.

Data numbering at beginning of record.

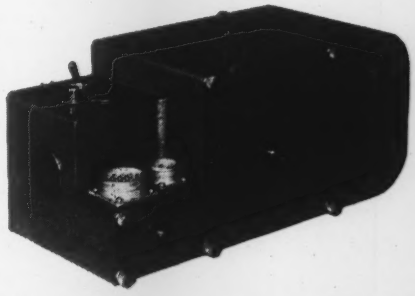
Footage indicator showing amount of paper remaining in magazine.

Automatic record length control.

Trace identification.

Remote control unit.

MODEL 409 OSCILLOGRAPH



The Century Model 409 oscillograph has been designed for recording data where space and weight requirements are limited. This oscillograph has been tested to record faithfully while subjected to accelerations up to 20 G's.

FEATURES:

Size: 5" x 5" x 11".

Weight: 11 pounds.

Cast Aluminum case.

Paper speeds variable ½" to 12" per second.

Detachable daylight loading magazine with a capacity of 3⅜" x 50' paper or film.

2 to 12 individual channels.

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Trace viewing.

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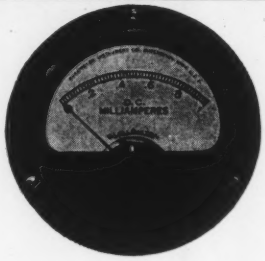

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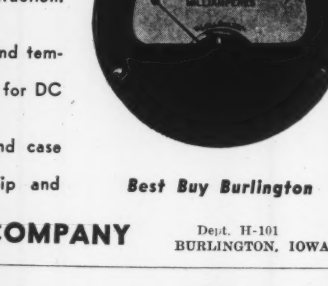

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NEW LITERATURE

Chemical Analysis Continued

principles and specifications.—Gow-Mac Instrument Co., 22 Lawrence St., Newark 5, N. J.

T-798 **Thermal Conductivity Cells.** 6-page folder "General Instructions" contains instructions for installation and operation of "Gow-Mac" thermal-conductivity cells.—Gow-Mac Instrument Co., 22 Lawrence St., Newark 5, N. J.

T-799 **Gas Analysis.** 60-page "Gas-Analysis Manual" presents theory of gas analysis by Orsat method (volume measurement), and maker's gas-analysis apparatus. Includes gas compositions and accessories.—Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Penna.

T-800 **Colorimeter.** 4-page Bulletin 201-D illustrates and describes maker's "Model 3700" colorimeter for absorption measurements of a flowing (or static) stream.—Beckman Instruments, Inc., S. Pasadena, Calif.

T-801 **pH Meter.** 4-page Bulletin 260 illustrates and describes new "Model N" pH Meter. Includes features, operation, and maintenance instructions.—Beckman Instruments, Inc., S. Pasadena, Calif.

T-802 **Air Pollution.** 8-page Vol. 11 No. 2 issue of house organ "Modern Precision" features articles on recording air pollution by SO_2, pH control in paper production, and others.—Leeds & Northrup Co., 4907 Stenton Ave., Philadelphia 44, Penna.

T-803 **Carbon Determinator.** 4-page brochure illustrates and describes maker's "CD-10" conductometric carbon determinator for iron and steel.—Laboratory Equipment Corp., St. Joseph, Mich.

T-804 **Induction Furnace.** 6-page brochure illustrates and describes maker's "1H-10" high-frequency induction furnace for the chemical laboratory.—Laboratory Equipment Corp., St. Joseph, Mich.

T-805 **Dessicator.** 4-page folder illustrates and describes dessicator with adjustable shelves for various sized crucibles.—Bethlehem Apparatus Co., Inc., Hellertown, Penna.

Gaging and Inspection

T-806 **Gage Blocks and Inspection Instruments.** 4-page Bulletin Sec. F1 illustrates and describes maker's gage blocks, caliper bars, sine bars, optical flats, comparators, and mobile inspection cart.—The DoAll Co., Des Plaines, Ill.

T-807 **Pneumatic Comparator Gages.** 24-page Bulletin 8004 illustrates and describes maker's line of pneumatic comparators for production gaging. Includes basic operating principles and quality-control use.—Moore Products Co., H & Lycoming Sts., Philadelphia 24, Penna.

T-808 **Pneumatic Gaging.** 20-page Booklet QC 5-51-75 illustrates and describes applications of maker's pneumatic gaging instruments in statistical quality control.—The Sheffield Corp., Dayton 1, Ohio.

T-809 **Brinell Hardness Testers.** 9-page catalog describes maker's "Type M 60/750 Dwarf Brinnell Press,"

"Zwerg" equipment with rotatable mount for extra-hard specimens, "Duroskop" impact hardness tester, dynamic hardness tester, and optical accessories. —The R. Y. Ferner Co., Inc., 110 Pleasant St., Malden 48, Mass.

Valves, Positioners, etc.

T-810 **Valves.** 72-page Catalog 51-52 illustrates and describes maker's line of drilling and production equipment, and lift-plug valves.—Cameron Iron Works, Inc., Houston, Texas.

T-811 **Valves.** 40-page Catalog No. V-50 illustrates and describes maker's line of Saunders-patent diaphragm valves. Includes features, materials, specifications, and data on accessories. —Hills-McCanna Co., 3025 N. Western Ave., Chicago 18, Ill.

T-812 **Valves.** 36-page Bulletin No. 155 illustrates and describes maker's large line of "Rotovalves," including hydraulic-operated, automatic check, pressure-regulating, level-control, poppet-type, motor-operated, manual, and surge-relief valves.—S. Morgan Smith Co., York, Penna.

T-813 **Packless Valves.** 54-page Bulletin 813 illustrates and describes maker's line of bellows-seal valves.—Fulton Sylphon Div., Robertshaw-Fulton Controls Co., Knoxville 4, Tenn.

T-814 **Lift-plug Valves.** 20-page catalog illustrates and describes maker's line of non-lubricated lift-plug valves. Includes features and specifications.—Cameron Iron Works, Inc., P. O. Box 1212, Houston, Texas.

T-815 **Leakproof Stuffing Box.** 20-page Vol. 10 No. 4 issue of house organ "The Flow Line" features descriptions of new leakproof stuffing box, centrifuge, cycloversion process, etc.—Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Penna.

T-816 **Valve Positioner.** 1-page Form 1-86 illustrates and describes maker's remote valve positioner which positions hydraulic cylinder according to a pneumatic signal.—Askania Regulator Co., 240 E. Ontario St., Chicago 11, Ill.

T-817 **Pneumatic Throttling Control.** 8-page Catalog C-1 illustrates and describes new "Rotomotor" pneumatic positioner for large valves with long strokes. Includes principles and features. —Conoflow Corp., 2100 Arch St., Philadelphia 3, Penna.

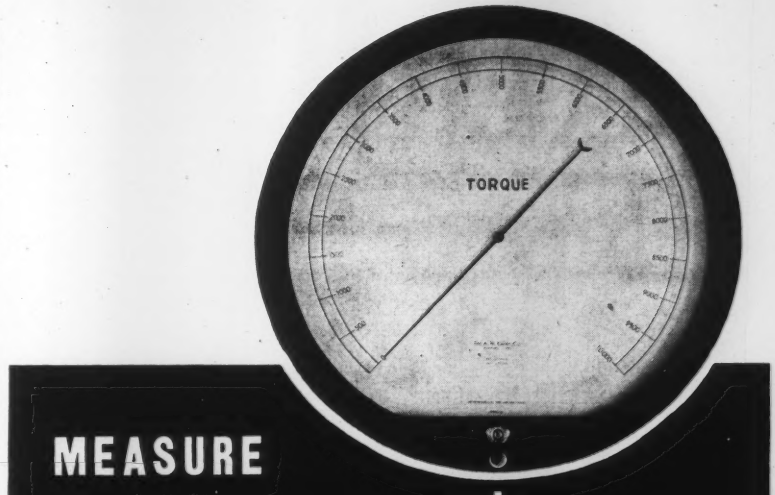
T-818 **Air-hydraulic Booster.** 1-page Form 1-87 illustrates and describes maker's remote-positioning unit which uses hydraulic booster for a pneumatic signal.—Askania Regulator Co., 240 E. Ontario St., Chicago 11, Ill.

Electrical and Electronic Instruments

T-819 **Electronic Scale.** 4-page brochure illustrates and describes new "Ametron" scale with load cells, electronic amplifier, and weight printer.—Streeter-Amet Co., 4101 Ravenswood Ave., Chicago 13, Ill.

T-820 **Moisture Meter.** 4-page Bulletin No. 1242U illustrates and describes maker's "TAG-Heppenstall" conductance moisture-meter for grain. —Tagliabue Instruments Div., Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

T-821 **Electrical Instruments.** 2-page Vol. 18 No. 7 issue of house organ



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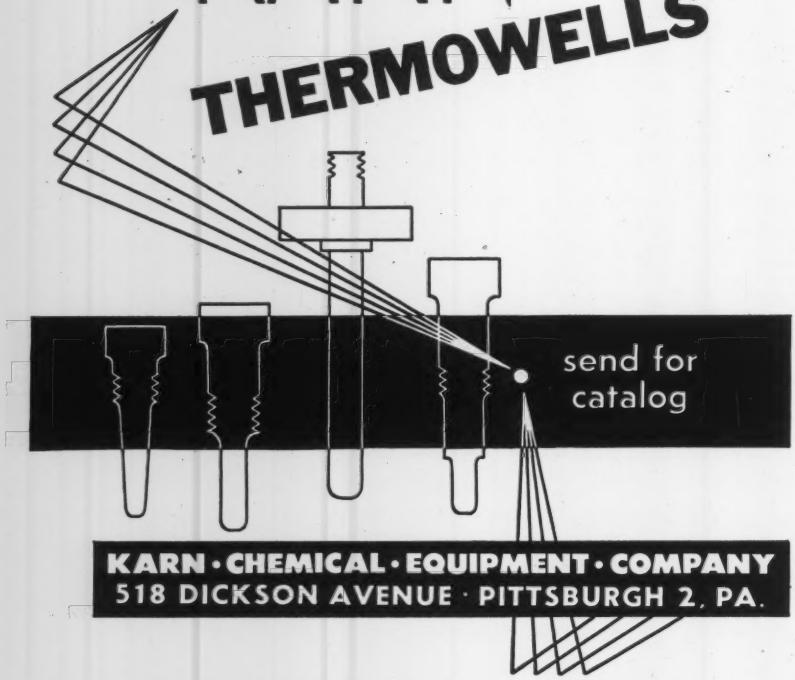

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NEW LITERATURE

Electrical & Electronic Instruments Continued

"Electrical Measurements" illustrates sensitive microammeter, electrostatic voltmeter, "polyranger" and d-c. voltmeter.—Sensitive Research Instrument Corp., 9-11 Elm Ave., Mt. Vernon, N. Y.

T-822 **Oscilloscope.** 2-page brochure illustrates and describes maker's high-gain wide-band oscilloscope with marker generator and calibrator.—Lavoie Laboratories, Inc., Matawan-Freehold Rd., Morganville, N. J.

T-823 **Oscilloscope.** 4-page bulletin illustrates and describes "Model WO-57B" low-cost oscilloscope suitable for instrument shops.—Radio Corporation of America, Harrison, N. J.

T-824 **Miniature Oscillograph.** 12-page Vol. 5 No. 3 issue of house organ "CEC Recordings" features articles on new miniature 9-channel oscillograph, new pressure pickups and mass-spectrometer design.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.

T-825 **Recording Oscillograph.** 16-page Bulletin CEC-1500B illustrates and describes new 18-channel high-speed recording oscillograph. Includes features and operation.—Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.

T-826 **Test Instruments.** 2-page bulletins illustrate and describe maker's (1) "Model 1500" megohm meter, (2) "Model 1010 Rotobridge" component inspector, and (3) "Model 1060" cable test stand for handling many cables without tangling.—Communication Measurements Laboratory, Inc., 120 Greenwich St., New York 6, N. Y.

T-827 **Test Instruments.** 8-page brochure illustrates and describes maker's line of laboratory standard test instruments—signal generators, noise and field-strength meters, VTVM's, frequency meter, crystal calibrator, and bridges. —Measurements Corp., Boonton, N. J.

T-828 **Regulated Power Supplies.** 2-page bulletins illustrate and describe maker's "Models 1100, 1110, and 1115" regulated "B" and "C" supplies.—Communication Measurements Laboratory, Inc., 120 Greenwich St., New York 6, N. Y.

T-829 **Harmonic Frequency Generator.** 4-page brochure illustrates and describes maker's secondary frequency standard which develops harmonic signals from 10 to above 2000 Mc.—Lavoie Laboratories, Inc., Matawan-Freehold Rd., Morganville, N. J.

T-830 **Signal Generators and Analyzers.** 66-page 1951 General Catalog A-51 illustrates and describes maker's large line of (1) high-frequency test equipment, (2) frequency-analysis equipment, (3) industrial-type speed analyzer, (4) TV, FM, and radar test equipment, and (5) accessories.—Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.

T-831 **Sweep Generators.** 2-page brochure illustrates and describes maker's (1) "Kilo-sweep" generator with frequency range of 50 kc. to 2 Mc., (2) "Sona-sweep" generator with range from 5 to 200 kc., and (3) "Marka-sweep" generator with range from 50 kc. to 20 Mc.—Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.

T-832 **Power Oscillators.** 2-page bulletins illustrate and describe maker's signal generators. "Model 1420" has 250-watt output from 50-6000 cps. "Model 1430" has 1400-watt output from 50 to 5000 cps.—Communication Measurements Laboratory, Inc., 120 Greenwich St., New York 6, N. Y.

T-833 **Transmission-line Fault Locator.** 6-page brochure illustrates and describes radar-type locator which uses pulse "echo" to find line faults.—Metrotype Corp., 525 W. 76th St., Chicago 20, Ill.

T-834 **Stroboscope.** 2-page bulletin illustrates and describes maker's "Model 1210 B" electronic stroboscope, including features and specifications.—Communication Measurements Laboratory, Inc., 120 Greenwich St., New York 6, N. Y.

T-835 **Data Tabulator.** 4-page bulletin illustrates and describes "Metrotype" system for numerically tabulating, recording, or telemetering of readings, data, records, etc.—Metrotype Corp., 525 W. 76th St., Chicago 20, Ill.

T-836 **Electrostatic Voltmeters and Optical Pointers.** 2-page bulletin illustrates and describes (1) "Model 1405 Group" electrostatic voltmeters and (2) "Model 18A22 Group" instruments with light-spot optical pointer.—Cole Instrument Co., 1320 So. Grand Ave., Los Angeles 15, Calif.

T-837 **Frequency Meter.** 4-page brochure illustrates and describes maker's line of precision frequency meters from 100 to 2000 Mc.—Lavoie Laboratories, Inc., Matawan-Freehold Rd., Morganville, N. J.

T-838 **Crystal-impedance Meters.** 2-page brochures illustrate and describe maker's "Model 50" and "Model 51" instruments which measure impedance and parameters of crystals.—Lavoie Laboratories, Inc., Matawan-Freehold Rd., Morganville, N. J.

T-839 **Intermodulation Measurement.** 16-page Vol. 16 No. 8 issue of house organ "CD Capacitor" features article on intermodulation measurement in audio amplifiers.—Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

T-840 **Dielectric-sample Holder.** 8-page Vol. 26 No. 3 issue of house organ "The General Radio Experimenter" illustrates and describes maker's sample holder for testing dielectric materials.—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

T-841 **Calibrating Voltmeters and Oscillators.** 4-page Vol. 2 No. 11 issue of house organ "hp Journal" features article on calibration methods used on maker's voltmeters and oscillators.—The Hewlett-Packard Co., 395 Page Mill Rd., Palo Alto, Calif.

T-842 **Oscilloscope Calibrating Standard.** 12-page Vol. 18 No. 7 issue of house organ "Sylvania News" features articles on a calibrating standard for oscilloscopes and TV marker generator. Sylvania Electric Products, Inc., P. O. Box 431, Emporium, Penna.

T-843 **Omnidirectional Radio Range.** 10-page catalog illustrates and describes maker's VOR radio-range equipment, including transmitter, monitors, antenna, etc.—Lavoie Laboratories, Inc., Matawan-Freehold Rd., Morganville, N. J.

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FLOWMETER and TACHOMETER
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NEW LITERATURE

Electrical and Electronic Components

T-844 Carbon-film Resistors. 2-page brochure illustrates and describes new precision microcrystalline carbon-film resistors. Includes features and specifications.—Kay Electric Co., 14 Maple Ave., Pine Brook, N. J.

T-845 Precision Resistors and VDR's. 2-page bulletin illustrates and describes new precision wire-wound voltage-dividing resistors (pots) and fixed resistors.—Cole Instrument Co., 1320 So. Grand Ave., Los Angeles 15, Calif.

T-846 Capacitor Replacement Guide. 34-page Catalog TVR-7 contains cross indexes of (1) original capacitors in TV receivers, (2) recommended replacement, (3) stock numbers, and (4) lists of maker's capacitors. Price is 50c.—Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

T-847 Electrolytic Capacitors. 24-page Engineering Bulletin No. 170 describes maker's etched-foil d-c. dry electrolytic capacitors. Includes size factors, physical and electrical characteristics, and operating and stabilizing data.—Cornell-Dubilier Electric Corp., S. Plainfield, N. J.

T-848 Tube Manual. Eighth edition of "Technical Manual" in loose-leaf format contains data on 500 receiving and TV tubes, plus 86 pages of data on vacuum-tube circuit operation. Cost is $2.00. Write to manufacturer.—Sylvania Electric Products, Inc., Emporium, Penna.

T-849 Differential Transformer. Engineering Data Sheet 55 illustrates and describes "Atcotran" differential-transformer transducer element with large motion.—Automatic Temperature Control Co., Inc., 5212 Pulaski Ave., Philadelphia 44, Penna.

T-850 Strain Gages. 1-page Bulletin 322 gives specifications of new post-yield strain gages for strains up to 10 percent.—Baldwin-Lima-Hamilton Corp., Philadelphia 42, Penna.

T-851 Strain Gages. 2-page Bulletin 174 illustrates and describes new temperature-compensated strain gages.—Baldwin-Lima-Hamilton Corp., Philadelphia 42, Penna.

Materials

T-852 Fused Quartz. 4-page No. 11 issue of house organ "Engelhard Industries News-Letter" features articles on fused quartz as replacement for critical materials, head-mounted work lights, and oxygen detection.—Engelhard Industries, 113 Astor St., Newark 5, N. J.

T-853 Precision Rolled Metals. 2-page folder describes facilities for reduction of nonferrous or ferrous metals and alloys to foil as thin as 0.0005 inch.—Precision Rolled Metals, Div. of Peerless Roll Leaf Co., Inc., 4519 New York Ave., Union City, N. J.

T-854 Core Materials. Data Sheet No. 1 tabulates basic materials in magnetic cores manufactured by 8 companies.—Metal Powder Association, 420 Lexington Ave., New York 17, N. Y.

T-855 Core Material. 12-page bulletin illustrates and describes maker's metallic-oxide "Ceramag" core materials with high permeability and low

eddy-current loss. Includes flux, hysteresis, and temperature characteristics. —Stackpole Carbon Co., St. Marys, Penna.

T-856 **Metal Powder.** 4-page Vol. 3 No. 1 issue of house organ "Metal Powder Press" features use of powder-metal parts in gears, dials, cams, levers, etc.—The New Jersey Zinc Co., 160 Front St., New York 38, N. Y.

T-857 **High-temperature Insulation.** 4-page brochures give tentative specifications of new "Surflene" high-temperature insulation and "Surflon" heat-resistant high-frequency insulation.—Surprenant Mfg. Co., 199 Washington St., Boston 8, Mass.

Instrument-shop Equipment

T-858 **Packaging.** 36-page Bulletin 44 M.G. outlines and indexes 30 government packaging specifications.—Mehl Mfg. Co., 2057 Reading Rd., Cincinnati 2, Ohio.

T-859 **Soldering-iron Tips.** Bulletin illustrates and describes maker's line of "Hi-heat" pencil-iron tips.—Ungar Electric Tool Co., Inc., Los Angeles 54, Calif.

T-860 **Dehumidifier.** 4-page Bulletin No. 322 illustrates and describes "Frigidaire" electric dehumidifier for reducing humidity in laboratories, shop space, etc.—Burrell Corp., 2223 5th Ave., Pittsburgh 19, Pa.

T-861 **Vapor Degreasers.** 12-page bulletin illustrates and describes maker's line of degreasing equipment for tanks and conveyors. Includes principle and applications.—Phillips Mfg Co., 3475 W. Touhy Ave., Chicago 45, Ill.

T-862 **Shaped Tape.** 4-page Bulletin 160 illustrates and describes maker's pre-cut, shaped pressure-sensitive self-adhesive "Quik-Masks" and "Quik-Sign" stencils.—Brady-Milwaukee Co., 204 W. Washington St., Milwaukee, Wis.

T-863 **Springs.** 8-page August issue of house organ "The Mainspring" lists ten sources for mechanical springs and features article "Quality Control in Spring Manufacture."—Associated Spring Corp., Bristol, Conn.

T-864 **Axonometric Drawing Instruments.** 2-page folder illustrates and describes maker's "Instramaster" drawing instruments for 3-dimensional (axonometric) drawings.—John R. Cassell Co., Inc., 110 W. 42 St., New York 18, N. Y.

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Miscellaneous

T-865 **Industrial Mixers.** 12-page Catalog 68 illustrates and describes

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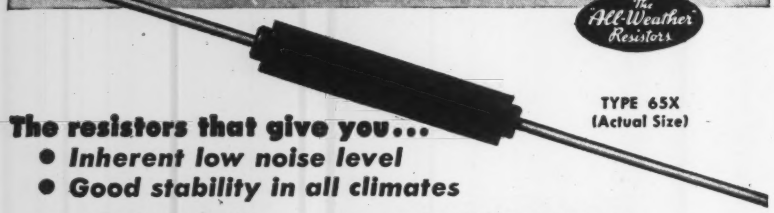

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NEW LITERATURE

Miscellaneous Continued

maker's "Dispersall" mixers for dispersing, emulsifying, and milling. Includes features and applications.—Abbe Engineering Co., 50 Church St., New York 7, N. Y.

T-866 **Laboratory Furniture.** 16-page booklet describing new plant in Silver Spring, Md., illustrates laboratory products, including laboratory furniture.—Fisher Scientific Co., 7722 Woodbury Dr., Silver Spring, Md.

T-867 **Fluorescent Lamps.** 12-page Booklet 1b-192 "Why You Should Use G-E Slimline Lamps" illustrates and describes construction features, and applications of maker's "Slimline" fluorescent lamps.—Lamp Department, General Electric Co., Nela Park, Cleveland, Ohio.

T-868 **Fluorescent Tubing.** 4-page bulletin describes new line of fluorescent sign tubing and chemicals which contain no hazardous beryllium.—Sampson Chemical & Pigment Corp., 2830 W. Lake St., Chicago 12, Ill.

T-869 **Luminous Paints.** 4-page folder illustrates and describes principles of radium-luminous, phosphorescent, and fluorescent compounds.—Sampson Chemical & Pigment Corp., 2830 W. Lake St., Chicago 12, Ill.

T-870 **Black-Light Blue.** 4-page bulletin describes fluorescent coated black-light "BL-UV" tubing for use with fluorescent paints on decorations and displays.—Sampson Chemical & Pigment Corp., 2830 W. Lake St., Chicago 12, Ill.

Calendar of Events

Oct. 22-24, 1951
7th Annual National Electronics Conference.
Edgewater Beach Hotel, Chicago, Ill.

Nov. 13, 1951
Society for Applied Spectroscopy, November meeting.
Dr. Hipple (NBS) will discuss Mass Spectrometry of Solids.
Socony-Vacuum Training Center, 63 Park Row, New York, N. Y.

Nov. 15-17, 1951
Instrument Maintenance Short Course. Sponsored by Southern California Meter Assn. Los Angeles Harbor Junior College, 111 Figueroa St., Wilmington, Calif.

Nov. 28-30, 1951
Scientific Apparatus Maker's Association.
Midyear Meeting, Laboratory Apparatus, Optical, Nautical, Aeronautical, Military Instruments Sections.
Hotel New Yorker, New York, N. Y.

Nov. 28-30, 1951
Society for Experimental Stress Analysis.
Annual Meeting & Exhibits.
Hotel Bellevue, Philadelphia, Penna.
Symposium subject: Education and Training for Experimental Analysis.

Dec. 6-7, 1951
AIEE Committee on Feedback Control Systems.
Conference on Feedback Control.
Scientists and engineers from various universities and industrial organizations will be on the program.
Chalfant-Haddon Hall Hotel, Atlantic City, N. J.

CORRECTION

In the August installment of Instrument Electronics, the 5th line, p. 948, which tells the leakage current of electrolytic capacitors, should read: This current is about 0.5 milliampere (*fixed*) *plus* 0.03 *milliampere* per microfarad of capacity . . .

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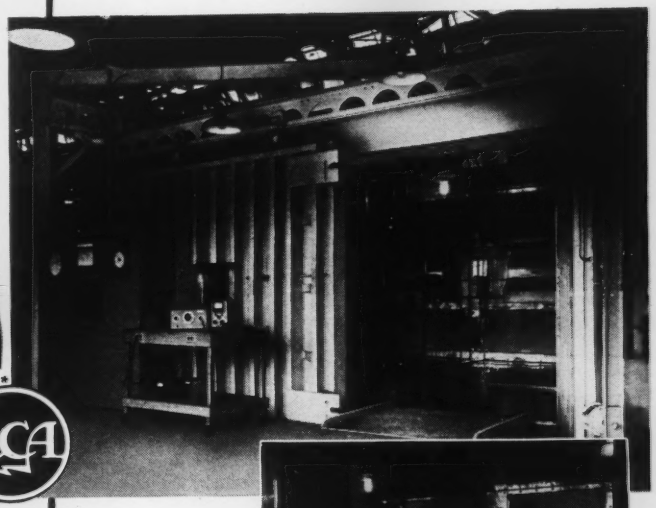

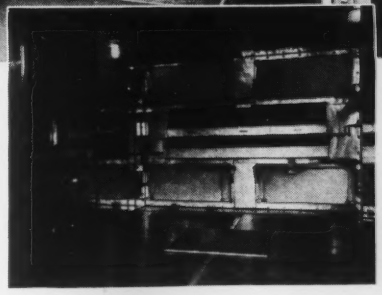

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